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RADICAL SINGLE STAGE EXTIRPATION FOR CANCER OF THE LARGE BOWEL, WITH RETAINED FUNCTIONAL ANUS

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FOR years the Miles operation for cancer of the rectum and rectosigmoid has been the most popular procedure of North American surgeons. The operation has been found to be radical, the technique is not difficult to master, and in skilled hands the mortality has been relatively low. The operation, however, has not been popular with the patient, for he objects to the abdominal colostomy, the postoperative impotence, the not infrequent persistent urinary dysfunction, and the occasional abdominal or perineal hernia. The operation also removes the means of making an early diagnosis of a pelvic recurrence by palpation through the bowel. These objections are largely due to the removal of the anus and part of the pelvic floor, based upon Miles's belief that rectal cancers spread downward, upward, and laterally. The pathological studies of Westhues and others (4-9) have shown that it is rare for rectal cancer to invade tissues more than 3 centimeters below the growth, which also is corroborated by our own clinical experience. As the anus, with its different lymphatic spread, is primarily involved in hardly 3 per cent of cancers of the large bowel, it is evident that for most patients with cancer of the rectum sacrifice of the anus and pelvic floor is unnecessary. However, the marked tendency to an upward and lateral lymphatic extension of rectal cancer can properly be met only by exposure and liberation through the anterior abdominal wall.

Beginning in 1904, I tried various perineal and sacral methods of resection for cancer of

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Fig. 1. The midline perineal incisions used.

Fig. 2. The incision divides the sphincters posteriorly and passes through the pelvic floor to the right side of the coccyx, which is not removed.

Fig. 3. The rectum is divided by scissors just above the sphincters as the upper rectal edge is grasped by a series of forceps.

Fig. 4. Four hemostatic forceps have now been attached to the upper edge of the partly divided rectum for light traction. The iodized gauze within the rectum is shown.

Fig. 5. Rectosigmoid free from all lower attachments.

Fig. 6. The rectosigmoid is withdrawn from the pelvis with the attached gauze tape, which indicates the lowest level of viable sigmoid.

Fig. 7. Withdrawn bowel showing lymphatic gland bearing mesosigmoid for removal.

Fig. 8. The withdrawn rectosigmoid has been wrapped in a towel and laid over the pubis. The sigmoid is held against the pubis by a trowel, the pelvis is inspected and cleared of clots, and the first deep suture of No. 32 stainless steel wire has been inserted into the levators but not tied.

Fig. 9. The open pelvic floor is being closed in the midline by three rows of buried interrupted sutures of No. 32 wire.

Fig. 10. The skin has been closed with interrupted sutures of No. 35 wire. The divided sphincters are not united.

Fig. 11. A finger tests the [illegible] that the sigmoid will not be strangulated by secondary swelling.

Fig. 12. Perineal gauze dressings moistened with compound tincture of benzoin have been applied, the sigmoid has been divided 6 centimeters from the skin, and a No. 28 rectal tube has been tied in.

the rectum, with or without retention of the anus; but, like others, found these operations insufficiently radical and associated with too high a percentage of postoperative complications. Turning to the more radical abdominoperineal operations, by 1939 I began to do the resection without colostomy or mutilation of the pelvic floor. In the development of the operation it was found that the viable sigmoid used to form the abdominal colostomy in the Miles operation usually was long enough (12 cm.) to be brought through the perineum. I have since transplanted to the perineum over 25 abdominal colostomies left after the Miles or other type of resection, and these patients have found the perineal opening without sphincters to require less protection, to be much more convenient to care for and less offensive from the escape of colonic gas than the previous abdominal colostomy.

It is desired to show iconographically by photographs of patients taken during, immediately after, and months and years after operation, the marked advantages of the method of abdominoperineal proctosigmoidectomy now used. The entire rectum and lower half of the sigmoid is removed, tributary lymphatics are resected to a high level, and the upper sigmoid is brought through the anus to unite spontaneously with the anal mucosa at the upper margin of the sphincters. The perineal part of the operation injures no important nerves or vessels and leaves a normal-appearing and functional anus and perineum without the tendency to fistula or sinus formation or to mucous prolapse of the Hochenegg or other conventional posterior resections, in which the sphincters ani are preserved.

The defecation sense or warning that the lower bowel has filled and should be emptied often is present a few days after the operation, voluntary contractions of the sphincters are produced at will, and nearly all of the patients after 4 to 8 weeks are able to dispense with a protective pad most, if not all, of the time.

TECHNIQUE OF THE ABDOMINO-PERINEAL RESECTION

Before operation the usual laboratory studies are made, and sulfasuxidine is given at 4 hour intervals for 3 to 5 days. Laxatives and enemas are used unless there is complete or nearly complete intestinal obstruction, when a catheter appendicostomy or cecostomy is formed through a small muscle-splitting incision, and the colon decompressed by irrigations every 2 to 4 hours with a 25 per cent glycerin solution or 10 per cent hydrogen peroxide. Parenteral feeding or transfusions are used before operation only for the very debilitated patient. The anesthesia is by spinal injection of 12 to 14 milligrams of pontocaine in 1 per cent solution, to which, largely to make it hyperbaric, 100 milligrams of procaine (novocain) is added. This is given through the first or second lumbar interspace, and the patient's head and chest are raised 10 degrees for the first 10 minutes, and then lowered. The analgesia usually lasts 2 to 3 hours. If Lemmon's fractional method of spinal anesthesia is used, it is desirable to inject a sufficient amount of the drug to prolong the anesthesia for an hour and to withdraw the needle just before the patient is put in position for the perineal part of the operation. In any case, an intravenous infusion is started immediately after the anesthetic is injected, from 500 to 1000 cubic centimeters of 5 per cent glucose followed by 500 cubic centimeters of blood usually being given. For marked hypotension, the head is lowered, and 1 per cent procaine containing 1 minim of epinephrine (1:1000) in each 10 cubic centimeters is freely injected about the wound field or, rarely, a few drops of dilute epinephrine solution are added to the infusion. With the exception of 1 patient with thousands of metastatic growths in his internal organs, in no case has sufficient shock or collapse developed to prevent the completion of the desired operation.

Abdominal phase. The preferred abdominal incision runs parallel with and 3 centimeters above the left inguinal ligament (Fig. 18), through the lateral edges of the sheaths of the left rectus muscle. The deep epigastric vessels are exposed, divided, and ligated, and the peritoneum is opened. With this incision the strong aponeurotic layers rather than muscle are divided in the depths of the wound. Should more room be required, the median portion of the incision may be carried through one or both recti, and laterally the incision may be

extended between the fibers of the internal oblique. This anatomic incision gives satisfactory exposure and the undivided upper abdominal wall holds the small intestine and retentive pads in place better than with a vertical incision, and rarely leads to a secondary hernia. If there is a lower median scar, a vertical incision is substituted by excising the scar. The upper abdominal organs and finally the pelvic organs are explored by palpation. The left lateral peritoneal leaflet of the sigmoid is divided, the left spermatic or ovarian veins are displaced laterally or divided and ligated, and the left ureter, recognized by its trombone-like movements on irritation, is freed from the peritoneum nearly to the bladder. The peritoneal incision is continued lateral to the rectum, to and then across the reflection of the bladder in men or the cervix in women. The hand is introduced from the left side under the peritoneum, which is elevated with the attached bowel and mesentery from the great vessels and underlying sacrum to the coccyx, any enlarged lymph nodes being particularly noted to the right of the bowel and along the elevated superior hemorrhoidal vessels. The inferior mesenteric vessels are doubly ligated with transfixion and divided below the left colic artery, and usually also the first sigmoid branch to enable the sigmoid curve to be straightened. The mesosigmoid is then divided to the bowel, usually between the first and second sigmoid arteries. Avoiding the ureter and sacral veins, the peritoneum is divided well to the right of the rectum, superior hemorrhoidal vessels, and lymph nodes, and the incision is continued to join the first peritoneal incision from the left side of the rectum. The lateral lower rectal ligaments and contained middle hemorrhoidal vessels are then located and divided wide of the rectum, these vessels usually not requiring ligation. With the aid of a trowel and long scissors the rectum is separated from the vesicles and prostate or, in the female, from the upper vagina. The sigmoid proximal to its divided mesentery is now tested for vascularity, if necessary by dividing small vessels on its surface, and a sufficient viable length (12 cm.) is liberated to reach from the sacral promontory through the pelvic floor. This may necessitate some mobilization of the lower part of the descending colon, with division of its lateral peritoneal leaflet. A soft tape of folded gauze 1 meter long by 4 centimeters in width is tied about the sigmoid at the level of proved vascularity, and the ends are packed back of the rectum against the floor of the pelvis. This gauze, by pressure, controls capillary oozing, serves as a guide in the perineal phase of the operation, and enables traction to be made on healthy, rather than cancerous, bowel. The denuded pelvis is not peritonealized and a peritoneal pelvic diaphragm has been found unnecessary. Thus the bladder is not displaced. The great omentum, as far as possible, is spread over the intestinal coils after the rectosigmoid has been placed in the pelvis. The deeper layers of the abdomen are then closed, preferably with interrupted layer sutures of No. 30 and No. 32 gauge stainless steel wire, which are tied in a square knot and the ends cut off very close to the knot. The skin and subcutaneous fat are united with interrupted No. 35 and continuous No. 38 stainless steel wire.

To remove blood and serous exudate from the pelvis during the early days after the operation, a perforated suction ("sump") drain (Fig. 18) 8 to 10 millimeters in diameter is carried on the left side of the bowel to the bottom of the pelvis and brought out through or near the lower angle of the incision. Low pressure aspiration of the inner tube of the drain is continued, as by a small electric pump, during the first 3 or 4 days after the operation. The intra-abdominal sump drain empties the pelvis of fluid that may serve as a culture medium or diffuse bacteria. It also immediately indicates the onset of a postoperative hemorrhage, its degree, persistence, or arrest. It gives the earliest sign of ileus by a sudden aspiration of quantities of clear serum 24 to 40 hours before distention, tympany, and vomiting attract attention. Guided by this warning, an aspirating indwelling duodenal tube is immediately introduced and often promptly relieves the obstruction. Likewise, the drain will give the earliest indication of an infection in the depths of the pelvis by the odor and appearance of the material aspirated.

Perineal phase. With the abdomen closed, the patient is placed in the lithotomy position, and the rectum is wiped out and packed with

gauze saturated with 3.5 per cent tincture of iodine. With the surrounding parts carefully asepticized, a midline incision is made through the posterior border of the anus, sphincters, pelvic floor to the right side of the coccyx (Figs. 1, 2) into the pelvis, where the gauze attached to the sigmoid is felt. The rectum is divided circularly with scissors just above the sphincters (Fig. 3) but well below the carcinoma, and its upper edge is caught as it is divided by a series of hemostatic forceps (Fig. 4). With gentle traction upon these forceps, and guided by the finger introduced in the midline, the levatores ani are elevated and cut laterally from the rectum, and the urethra and prostate or vagina are separated anteriorly, when the liberated rectum and sigmoid are easily withdrawn as the wound is held apart by lateral retractors (Figs. 5, 6, 7). The withdrawn bowel is wrapped in a towel and placed over the pubis on the abdomen. With a trowel holding the sigmoid portion against the pubis (Fig. 8), the pelvic cavity is sponged dry, and any bleeding points are ligated. The perineal wound is relatively avascular, and no ligatures may be required. The levatores ani are united in the midline in layers with No. 32 gauge stainless steel wire interrupted sutures, *without constriction* of the bowel (Figs. 8, 9). Otherwise, the secondary swelling may strangulate the withdrawn sigmoid. Omentula should not be trimmed from the bowel as they contain nutrient blood vessels and occasionally a diverticulum. The skin and fat are closed with fine (No. 35 gauge) interrupted wire sutures (Fig. 10). After the perineum has been closed it should be possible readily to introduce the finger between the bowel and sutured pelvic floor (Fig. 11). Dressings are applied and the bowel is incised about 6 centimeters distant from the skin, a No. 28 F. rectal tube is inserted, and securely tied in with two encircling ligatures, and the rest of the bowel is cut away (Fig. 12). A retention catheter is fastened in the bladder for the first 3 to 6 days, to be irrigated with boric or other solution daily. It will be observed that the perineal floor is closed without drainage. With this technique less than 4 per cent have developed a perineal infection. This is attributed to the iodine sterilization of the rectum and the exclusive use of stainless wire sutures and ligatures in this region. As the withdrawn sigmoid is surrounded by a vascular tube of anus and muscular pelvic floor to a depth of 5 to 7 centimeters, it is evident that the withdrawn bowel may slough back into the pelvic floor for several centimeters without ill effect. If there is question as to the sterility of the pelvic wound, a curved perforated glass or metal drain or a large cigarette drain is to be inserted through the perineum to the anterior surface of the sacrum. With evidence of limited malignant invasion of the prostate or vagina, these should be resected. With irremovable extension into the base of the bladder and pelvic floor, we have formed

Fig. 13. Showing viable protruding sigmoid and primary healing, 9 days after operation. (Mr. A., aged 62 years, out of bed 3 days after operation.)

Fig. 14. Removal of redundant sigmoid 2 centimeters beyond the skin, without anesthesia, with a tonsil snare. (Mr. B., aged 62 years, obstructive "benign? papillary adenoma of the rectum," "metastatic carcinoma of pelvic lymph nodes and organs.")

Fig. 15. Retraction of end of sigmoid immediately after use of snare. (Mr. B.)

Fig. 16. Redundant sigmoid 12 days after abdominoperineal resection. (Mr. C., aged 60 years, mucohemorrhagic stools for 5 months. Partial obstruction for a period of several weeks. Invasion of base of bladder, prostate and adjacent pelvis.)

Fig. 17. Bulky redundant sigmoid from obesity, 12 days after abdominoperineal resection. (Mrs. D., aged 62 years, "malignant polyp" removed from rectum 5 years previously. Melena for 2 years. Barium roentgenograms "negative.")

Fig. 18. Abdominal scar 7 days after abdominoperineal resection. Stainless steel sump drain used the first 4 days. (Mr. E., aged 64 years, good condition 23 months after operation. Enema every 3 days. No anal protection required.)

Fig. 19. One month after operation. (Mr. F., aged 56 years. Melena for 1 year, treated by hemorrhoidal injections. Excellent condition, good defecation sense, uses enema every 2 days, rarely soils.)

Fig. 20. Seven months after operation. (Mr. H., aged 69 years. Uses laxative once a week. No pad is required, no soiling.)

Fig. 21. Thirty-two months after operation. (Mrs. I., aged 25 years. Good control, good defecation sense, no soiling.)

Fig. 22. Three years after operation. (Mrs. J., aged 39 years. No pad required.)

Fig. 23. Fifteen years after early type of author's abdominoperineal resection and secondary anal plastic operation. (Mr. K., aged 68 years. Good control with enema every 4 days. Slight anal moisture from exposed mucosa, for which a wisp of cotton is worn without pad or belt.)

Fig. 24. Seventeen years after perineal anoproctectomy and secondary plastic operation. (Mr. L., aged 56 years. Evacuation after each meal. Good warning and control. No pad required.)

Fig. 13.

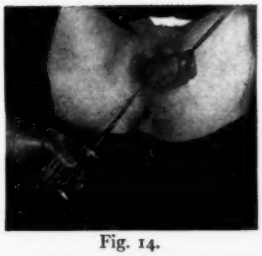

Fig. 14.

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Fig. 18.

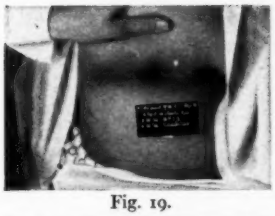

Fig. 19.

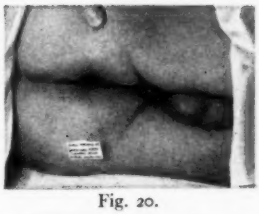

Fig. 20.

Fig. 21.

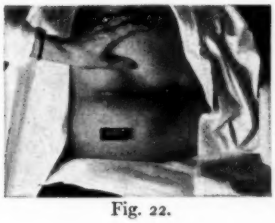

Fig. 22.

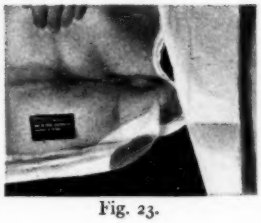

Fig. 23.

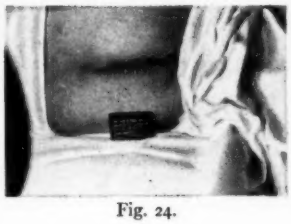

Fig. 24.

the anal outlet as described with satisfactory palliation (Fig. 16).

About 6 days after the operation the rectal tube will slough out of the bowel, as a rule leaving a length of living bowel protruding from the anus (Figs. 13, 16, 17). Two to 6 days later, provided the perineal wound is well united, the redundant or protruding bowel is snared or burned off 1 or 2 centimeters beyond the skin, by means of a heavy tonsil snare (Figs. 14, 15) or a clamp and galvanocautery. No anesthetic is required for this division as the bowel is insensitive. All bleeding should be controlled when the bowel is divided. The protruding end of the sigmoid soon spontaneously retracts and disappears within the anus, to unite with the edge of the anal mucosa just above the sphincters. If hemostasis is imperfect, bowel divided too close to the skin may retract too high and bleed back into the colon, with exsanguination and no telltale escape of blood from the anus.

Seven to 9 days after the operation the patient is permitted to be out of bed, and often will be in condition to leave the hospital on the eleventh to fourteenth day. At this time he will be able to contract his sphincters voluntarily, and usually will have acquired a defecation sense. As a rule he will not be able to retain liquid or semiliquid sigmoid contents, and should be instructed to take a quickly acting laxative, such as sodium sulfate, 8 grams in water, 120 cubic centimeters, every second to fourth day, on arising. After 2 months (Figs. 18, 19), an enema or colonic irrigation may be substituted for the laxatives, used at intervals of from 2 to 5 days, as determined by the personal habits of the patient. Except during periods of watery diarrhea, most patients then have little or no soiling and can dispense with a protective pad most or all of the time. The narrow annular scar uniting the sigmoid to the anal mucosa should be dilated frequently if it tends to contract. The patient may be given a set of test tubes or other dilators to be inserted daily after complete healing has occurred, or instructed to insert a gloved finger until a permanent adequate opening has been established. A strictured opening will prevent complete evacuation and lead to colic and annoying dribbling. Eventually satisfactory evacuation habits may be established for many patients without artificial aid or by the daily use of one or two teaspoonfuls of one of the bulk-producing, mucilaginous powders (metamucil, mucilose, kentos) derived from one of the varieties of plantain seed or other vegetable. Such powders are to be quickly stirred in a glass of cold water and drunk on retiring or arising. Other patients prefer an enema or quickly acting mild saline taken every 2 to 5 days. Even when cancerous invasion of the anus has made it necessary to remove the sphincters (Fig. 24), the foregoing measures will render the perineal colostomy preferable to an abdominal colostomy provided an opening of sufficient caliber is maintained and the more troublesome laxative foods are eliminated from the diet.

It should be noted that the operation, except for the removal of redundant bowel, is performed in one stage; that no attempt is made to peritonealize the denuded pelvis; that the sphincters are not denuded of their mucous membrane covering; that the sigmoid withdrawn through the anus or pelvic floor is *not sutured* to the skin or other structures, nor is the projecting portion cut away until at least 7 days have elapsed. Rhythmic longitudinal contractions continue in the withdrawn bowel, causing holes or small contaminating fistulas if sutures are introduced and early and undesirable retraction when the bowel is cut flush with the skin. Minor modifications of the operation may be found desirable. Formerly I used a fairly large perforated glass or rustless steel tubular drain in the perineum instead of an abdominal sump, but an occasional serious perineal infection occurred, attributed to the open drained wound in an area difficult to protect adequately from soiling. For those inexperienced or who use catgut in the perineum, I would advise pelvic drainage by tube or a large cigarette drain. My colleague, Dr. H. E. Bacon, divides the anal mucosa close to the skin margin, and dissects it from the sphincters. This procedure enables the denuded sphincters to be stretched sufficiently for the withdrawal of the rectosigmoid, and a week or more later when the protruding bowel is trimmed back, he sutures the margins to the skin edges with catgut. Unless the sphinc-

ters are divided, or denuded and stretched, they tend to contract upon the contained bowel, with resulting gangrene and pelvic infection. A chronic "wet anus" results when mucous membrane remains exposed at the anus.

During the last 3 years I have had no case of postoperative ileus from the lack of a pelvic diaphragm or pelvic peritonealization, and a few secondary operations have shown a surprising degree of spontaneous postoperative peritonealization. However, in a small series I have resected the rectosigmoid between short clamps through the abdominal incision, covered the clamped ends with stockinette, formed an overlying pelvic peritoneal diaphragm, and completed the operation from below. There was no evident advantage from this additional procedure, and 1 patient was lost from the slipping of a clamp. The bulk of the liberated rectosigmoid usually is so great that it is necessary to resect it to enable the formation of a satisfactory pelvic peritoneal diaphragm.

For carcinoma of the anus, the pelvic floor and rectum are widely resected and a perineal colostomy is formed. As anal growths have a lymphatic spread around the medial side of the thighs to the medial, and later to more lateral, inguinal lymph nodes, rather than an upward extension along the superior hemorrhoidal vessels, a perineal resection may be used with a perineal colostomy, followed by excision of the inguinal lymphatics.

Is the pull-through type of operation less radical than that of Miles, as might be shown by a higher percentage of recurrences in the perineum and pelvic floor? In a series of 304 personal operations of this type performed since 1929, only one possible recurrence in the transplanted sigmoid has been observed. This was a small papillary carcinoma developing within a year after the primary operation, upon the sigmoid mucosa about 3 centimeters above its lower border, that did not extend outside the wall of the bowel. It was excised 2 years ago and has not recurred.

While recurrences in the pelvic floor and perineum after excision of anal carcinomas, and recurrences in the prostate, bladder, and vagina after the operation for rectal carcinoma are rather common, recurrences definitely below the level of the primary carcinoma have not been found after the pull-through operation. In 3 cases, however, in which I attempted to transplant the colostomy from a Miles operation to the perineum, evidence of an unsuspected malignant infiltration was found in the pelvic floor. In a fourth patient there was a suspicious induration in the pelvis, without biopsy, while a fifth developed a carcinoma of the base of the bladder several years after the colostomy was transplanted. One of the patients with a gelatinoid carcinoma in the floor of the pelvis lived 17 years after his original Miles operation and 6 years after the colostomy was moved through the diseased pelvic floor to the perineum. While a minute urinary fistula developed, the perineal colostomy was convenient as it functioned only when an enema was used.

Resection of the colon. Improvements in the single stage aseptic resection of the large bowel with end-to-end anastomosis, which have reduced the mortality to about 4 per cent or less, have greatly increased the use of operations of this type. At present I am operating upon nearly all carcinomas of the large bowel, situated 11 centimeters or more above the anus, in this manner, using a Furniss or other modification of the Donati clamp. The arms of the liberated loop of bowel are aligned in the clamp, the loop of colon is removed by cautery, the clamp is taken off, and anastomosis is made over the shirring pin by an inner row of No. 00 chromic catgut and an outer seroserous row of interrupted No. 36 gauge stainless steel wire or fine silk sutures. For resections of the left colon, the bowel contents being solid, a provisional appendicostomy or cecostomy is made, the appendix being brought through a 1 or 2 centimeter stab wound at McBurney's point, a No. 16 or 18 F. catheter is tied in and the appendix or cone of cecum is anchored by suture or ligature to a dental cotton roll to prevent retraction. To liquefy solid fecal collections, repeated irrigations through the catheter of 10 per cent peroxide of hydrogen or the instillation of 25 per cent solution of glycerin are used. For the right colon, as the intestinal contents are liquid, a provisional enterostomy is unnecessary.

The Paul-Mikulicz operation, particularly for the rectosigmoid, is insufficiently radical, has a higher operative mortality,[1] a greater morbidity, and the highest incidence of recurrence in the abdominal wall, adjacent bowel and mesentery, and of secondary hernia. However, if the bowel ruptures or is perforated, it provides the quickest way to terminate the operation. I have not used this method or its modifications in the last 3 years.

For some years I have been practicing radical excision without colostomy for ineradicable carcinoma of the large bowel. In this way a considerable proportion of patients with ineradicable carcinomas have had the primary growth removed and have lived longer and more comfortably than if a palliative colostomy had been done. Of the last 300 patients seen, only 3 per cent were considered to have disease too far advanced for palliative resection. Several had had a colostomy, which also was eliminated. About 20 per cent had secondary palpable growths in the liver, and 13 per cent had extension of the cancer to other abdominal organs, yet most of these patients, after radical resection with primary wound closure, lived from 7 months to several years in improved health.

Hospital mortality. In a personal experience of 617 radical operations for cancer of the large intestine the mortality has markedly decreased with experience, improvements in technique, and the routine use of antibiotics. Of the last 300 patients entering my service, 97 per cent (aged from 21 to 87 years) have had radical intestinal resection. A number of these had a previous colostomy without extirpation of the cancer. Three per cent had disease so advanced that even a palliative operation was considered of no advantage. Ninety-seven per cent, about one-third with advanced and ineradicable malignancy, had a radical resection of the cancerous bowel, with a hospital mortality of 9 per cent. However, in the series there were 66 consecutive radical operations with 1 death, and in a rather recent series of 100 admissions for carcinoma of the large bowel, 2 were found to have disease too extensive for resection or colostomy, with 1 hospital death. Ninety-eight had radical resection, including 18 with palpable metastatic carcinoma of the liver and 13 with cancerous invasion beyond the bowel. Three with carcinoma of the anus had perineal resection with perineal colostomy, without mortality. Forty-four had the abdominoperineal operation with retained anus, with 2 hospital deaths (1 with advanced carcinoma of the liver), a mortality of 4.5 per cent; 51 had one stage, abdominal, aseptic, end-to-end resections, with 2 hospital deaths (3.9 per cent), 1 from coronary occlusion, 1 from peritonitis. Sixteen of these 51 end-to-end resections were for cancer of the rectum, 22 for cancer of the sigmoid or descending colon, and 13 for cancer of the right or transverse colon.

[1]Twelve per cent (personal series): "approximately 11 per cent" in over 450 cases, Lahey Clinic (3).

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PROGNOSIS IN CARCINOMA OF THE COLON AND RECTUM

A 10 Year Follow-Up of 337 Patients

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IT is a well known but occasionally forgotten fact that the term "five year cure" is little more than a convenient yardstick when used in connection with patients suffering from malignant disease. It will give an approximate idea of the end-results in a group of patients with malignant disease in one site or another, but it cannot be applied to the individual patient. Some of these people who have survived 5 years following the removal of their cancer will ultimately die of their original disease. This is true of carcinoma of the colon and rectum just as it is of carcinoma of the breast and other viscera. It is of interest and of value to know the results in these patients with carcinoma of the colon and rectum 5 years after operation and what the chances are for an individual patient with a malignant lesion to live, not only 5 years, but 10 or more years following resection of the malignant tumor.

In 1929, Jones reported a 22.7 per cent mortality in a series of 204 cases of carcinoma of the rectum in which the patients were treated by abdominoperineal resection. Seventy per cent of the patients who survived operation were alive and well at the end of 3 years and 50 per cent were living 5 years after their operation. His operability or resectability rate was 53 per cent.

Miles, in 1931, followed a group of 94 patients who had survived abdominoperineal resection for carcinoma of the rectum, and found 69 alive and well at the end of 5 years. This is a 5 year nonrecurrence rate of 73.3 per cent.

Abel, in 1935, found a 69.2 per cent survival rate in 150 patients whose course was followed for 5 years following abdominoperineal resection for carcinoma of the rectum. These figures are somewhat higher than those found in this country.

In 1933, Rankin, in a follow-up of 300 patients who had had resection for carcinoma of the rectum, found a 5 year survival rate of 48 per cent in those patients who showed no metastasis to lymph nodes in the resected specimen. In the group of patients in whom the lymph nodes were involved, 20 per cent survived 5 years. In 187 cases of carcinoma of the right colon, Rankin and Olson obtained 5 year "cures" in 39 per cent of their patients with nodal involvement, and in 66 per cent of those without nodal involvement. In 266 cases of carcinoma of the left colon, their figures were 29 per cent and 56 per cent, respectively.

In 1943, Cattell found 53.6 per cent of 140 patients who had survived resection for carcinoma of the colon or rectum were living 5 years or more after operation. This figure was based on all patients submitted to resection, and included palliative operations and unfavorable resections as well as favorable cases. It is of great value to know the operability or resectability rate in evaluating statistics relating to end-results, for, in any group of cases, if the patients with unfavorable lesions are not submitted to resection, the survival rates naturally will be higher. The operability rate in this group of patients was 83.5 per cent.

In 1943, Mayo and Twyman followed 79 cases of carcinoma of the rectum and found that 70.9 per cent of the patients with favorable lesions and 45.5 per cent of those with unfavorable lesions were alive and well 3 years after operation. In 1945 Hayden, in reviewing 198 patients with carcinoma of the rectum who were submitted to resection, found a 5 year "cure" rate of 33 per cent among the 98 patients whose course was followed for 5 years or more. His resectability rate was 80.6 per cent for all patients seen and 88.0 per cent for the group who came to operation.

The spread of carcinoma of the colon or rectum through the adjacent lymphatics has long been understood. For many years we have routinely isolated and examined the mes-

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enteric lymph nodes in each resected specimen for the presence of metastatic carcinoma. The significance of nodal involvement to the prognosis in the individual case is apparent from the present study and from the cases reported in the literature. Only in recent years, however, has the frequency with which carcinoma of the colon and rectum may spread through the vascular system been fully appreciated. Any discussion of prognosis following resection for carcinoma of the colon and rectum should emphasize the seriousness of blood vessel invasion as seen in the microscopic examination of the resected specimen. In one study of 208 patients we found that, of those patients who had shown blood vessel invasion at the time of operation, only 15 per cent were alive 5 years later.

In the present study, the case histories of 337 patients with carcinoma of the colon and rectum were carefully reviewed. All were treated prior to 1936, and 307 of these patients have been followed for at least 10 years.

The patients were divided into two main groups. In the first group were those with carcinoma of the colon, including carcinoma of the cecum, ascending, transverse, descending, and upper sigmoid colon. The second group consisted of patients with carcinoma of the lower sigmoid, rectosigmoid, and rectum since in these cases some type of resection of the rectum and rectosigmoid, with the establishment of a proximal colostomy, was carried out.

CARCINOMA OF THE COLON

There were 103 patients with carcinoma of the colon. The youngest patient was 27 years of age, the oldest 74, and the average age was 57 years. The incidence of carcinoma of the colon was slightly higher in women (56) than in men (47), whereas the reverse was true for carcinoma of the rectum.

Eighty-one of the 103 patients were submitted to some type of resection, including 14 palliative resections. This is a resectability or operability rate of 78.6 per cent. Three of the palliative resections were definitely so because of the presence of liver metastases at the time of operation, and 11 others were considered so because of local invasion at the time of resection. There were 22 patients in whom resection was not considered feasible. Three patients were not operated on, 4 had laparotomy only, 2 had cecostomy, and 13 had a sidetracking anastomosis, such as an ileotransverse colostomy or colocolostomy.

A modified Mikulicz type of resection was done in 76, or 94 per cent of the patients submitted to resection. A two stage resection consisting of a preliminary anastomosis followed by resection subsequently was done in 4, and a one stage resection with primary anastomosis was performed in 1 case. A tendency toward a one stage procedure for resection of carcinoma of the right colon is shown by the comparison of these figures with those for 1945 when a one-stage procedure with primary anastomosis was carried out in 17 per cent of patients with carcinoma of the cecum, ascending colon, and hepatic flexure. In the remainder a modified Mikulicz type of resection, which we still prefer for carcinoma of the left colon, was performed. The modified Mikulicz procedure has two distinct advantages over other two stage procedures. In the first place, it removes the growth at the primary operation and at the same time avoids an intraperitoneal anastomosis, and in the second place, the second stage is an extraperitoneal type of procedure.

Mortality. Five deaths occurred in the group of patients in whom the malignant tumor was limited to the bowel wall. Eight deaths occurred in the group in which the carcinoma already had invaded either the adjacent lymph nodes or neighboring viscera. This is a mortality of 16.0 per cent in the resected cases. In line with the marked reduction of the mortality noticed in all surgical centers interested in the treatment of carcinoma of the colon, it may be noted that the mortality in this group of patients in 1945 was 2.3 per cent. This has been accomplished in spite of the fact that the operability rate has continued to rise and in 1945 was 90.7 per cent. Three deaths occurred among those patients in whom only laparotomy or a palliative anastomosis was possible.

Follow-up. In the group in which the regional lymph nodes and adjacent viscera were not involved there were 38 patients in whom the 10 year follow-up was complete. Of this group, 5 patients died in the hospital; 5 other

TABLE I.—CARCINOMA OF COLON

Type of operation	Hospital deaths	Patients dying of carcinoma following operation							Living and well 10 or more years	Deaths from other causes	Total
		1–6 mos.	6–12 mos.	12–18 mos.	18–24 mos.	24–36 mos.	3–5 years	5–10 years			
Laparotomy only	1	2	1	0	0	0	0	0	0	0	4
Ileocolostomy or cecostomy	2	6	5	0	0	0	0	0	0	0	13
Resection; liver metastases present	0	0	0	2	1	0	0	1*	0	0	4
Resection; liver negative; metastases in lymph nodes	8	1	4	3	3	3	1	1	3	0	27
Resection; liver negative; lymph nodes negative	5	1	2	0	2	1	4	2	16	5	38
Sarcoma	0	0	0	1	0	0	0	0	0	0	1

*Nodules noted in liver at time of operation; biopsy not done and may not have been metastases.

patients subsequently died from causes other than recurrences of the carcinoma. These patients had lived from 3 months to 8 years following operation with no evidence of recurrence at the time of death from other causes.[1] Of the remaining 28 patients, 18 were living and well at the end of 5 years, 2 died of recurrent malignant disease between their fifth and tenth postoperative years, and 16 were living and well 10 or more years following resection of their malignant lesion. In 12 additional cases the 10 year follow-up was incomplete, although 6 of these 12 patients are known to have been living and well 5 or more years after operation. Thus, in the group of patients who survived operation and in whom the 10 year follow-up is complete, the 5 year survival rate is 64.3 per cent and the 10 year survival rate is 57.1 per cent.

Of the 27 patients in whom the malignant disease had extended to the adjacent lymph nodes or involved the surrounding structures, 8 died in the hospital and 15 died of recurrence of their disease within 5 years (Table I). One patient died of a recurrent carcinoma after having survived 5 years and 3 patients are living and well 10 or more years after operation. Thus, for this unfavorable group, the 5 year survival rate has dropped to 14.8 per cent and the 10 year survival rate to 11.1 per cent. One patient with sarcoma of the colon died less than 18 months after operation from recurrence of his malignant disease. Four patients in whom resection was done in the presence of liver metastases lived from 1 to 5 years following operation. In the one case in which the patient survived more than 3 years, there is some question as to whether the nodules noted in the liver at the time of operation were actually metastases, since no biopsy specimen was obtained. Of the 4 cases in which laparotomy only was performed, not 1 patient survived a year. The same was true for the 13 patients in whom only a sidetracking anastomosis was carried out.

[1]Since these figures are being examined from the point of view of recurrence or nonrecurrence of carcinoma of the colon and since those patients who die from other causes represent an unknown quantity in this respect, it seems reasonable that they should be excluded in the final analysis. It is important, however, to know the number of these patients and the length of time after operation when death occurred. No patient should be excluded who was not free of all evidence of recurrence at the time of death.

CARCINOMA OF THE RECTUM AND RECTOSIGMOID

There were 234 patients with carcinoma of the rectum and rectosigmoid. Of these, 129 were males and 105 were females. Their ages ranged from 21 to 75 years, with an average age of 57 years. It is worth while to note again that carcinoma of the rectum is found not uncommonly in patients under the so-called "cancer age." Nineteen patients, or 8 per cent of the entire group, were under 40 years of age.

Procedure. One hundred forty-six patients, or 62 per cent of this group, were submitted to some type of resection. A two stage Lahey procedure was performed in 83 or 56.8 per cent of the 146 patients, a one stage abdominoperineal (Miles) resection in 24, or 16.4 per cent, a posterior resection in 22 or 15.0 per cent, and an anterior resection (with permanent colostomy) in 17 or 11.6 per cent. Eighteen of these resections were considered palliative, 11

TABLE II.—CARCINOMA OF RECTUM AND RECTOSIGMOID

Type of operation	Hospital deaths	Patients dying of carcinoma following operation							Living and well 10 or more years	Deaths from other causes	Total
		1–6 mos.	6–12 mos.	12–18 mos.	18–24 mos.	24–36 mos.	3–5 years	5–10 years			
Laparotomy only	1	7	1	0	0	0	0	0	0	0	9
Colostomy only	29	18	15	2	1	1	1	0	0	0	67
Resection; liver metastases present	0	1	5	3	0	0	1	0	0	0	10
Resection; liver negative; lymph nodes involved	5	1	6	2	9	5	7	3	10	4	52
Resection; liver negative; lymph nodes negative	6	1	3	1	10	8	1	5	31	7	73
Sarcoma	0	0	0	1	0	0	0	0	0	0	1

definitely so because of the presence of liver metastases and 7 probably so because of invasion of adjacent structures. A steady tendency toward the increasing use of the one stage Miles abdominoperineal resection is shown by the fact that this procedure was used in 16.4 per cent of the above group, 76.7 per cent in the year 1941, and 97.5 per cent in 1945. Resection was not carried out in 88 cases, a colostomy having been done in 62, a first stage Lahey procedure in 10, and a laparotomy only in 11. No operation was performed in 5 cases.

Mortality. Of the 146 patients who were submitted to resection, including 18 palliative resections, there were 11 deaths, or a mortality for the resected cases of 7.5 per cent. Since 1936 the operative mortality for carcinoma of the rectum has dropped to 3.8 per cent in 1941 and 6.2 per cent in 1945. At the same time the operability rate has increased from 62 per cent to 83 per cent.

Twenty-eight deaths occurred in the group of patients whose growths were so extensive that only laparotomy or colostomy was possible.

Follow-up (Table II). In the group of 73 patients in whom there was no evidence of involvement of the liver or lymph nodes at the time of resection, 31 patients are known to be living and well 10 or more years following their operation. At the end of 5 years following operation 36 patients were living and well without evidence of recurrence. Five patients died from recurrence of the carcinoma between their fifth and tenth postoperative years. Twenty-four patients died from recurrent carcinoma in from 1 month to 5 years following operation. Seven patients subsequently died from other causes, with no evidence of recurrence at the time of their death (5 of these 7 patients had survived without recurrence 4½ to 7 years after their resection). There were 6 postoperative or hospital deaths. The 1 patient with sarcoma of the rectum died from recurrent malignant disease less than 18 months after his operation. Omitting the 6 postoperative deaths and the 7 patients who died from causes other than the recurrence of their carcinoma, the 5 year survival rate is 60 per cent and the 10 year survival rate is 51.6 per cent.

In 52 cases no metastases were noted in the liver at operation, but the carcinoma was found to have spread to the mesenteric lymph nodes on examination of the resected specimen. Of this group, 10 patients are living and well 10 or more years following their operation. Three patients died from a recurrence of their malignant disease between their fifth and their tenth postoperative years. There were 5 postoperative deaths and 4 other patients subsequently died from other causes, with no evidence of recurrence at the time of their death. Omitting the postoperative deaths and the patients who died from other causes than malignant disease, the 5 year survival rate is 30.2 per cent and the 10 year survival rate is 23.2 per cent.

In the entire group, 28 patients died of their disease within 6 months of operation. Of these, 25 or over 89 per cent, occurred in the group in whom only laparotomy or colostomy was possible. Thirty patients died of their

disease in 6 to 12 months after operation. In 16, or 53.3 per cent, resection was not possible, and in an additional 16.6 per cent liver metastases had been noted at the time of the palliative resection. Although there was no difference in the length of survival of patients who had resection of their growth in the presence of liver metastases and those who had colostomy only (only 1 patient in each group lived more than 3 years), there was a marked difference in the postoperative clinical course. Those patients, in whom the rectal lesion was left *in situ* were usually very uncomfortable from the constant discharge of mucus and blood from the rectum, and they often had severe pain from sciatic and perineal nerve involvement. Those patients in whom the primary growth was removed were usually comfortable until within a few weeks of their death.

Of the 15 patients in whom the 10 year follow-up was incomplete and who were not included in the above analysis, 6 patients had had such advanced disease that only a laparotomy or colostomy was possible at the time of operation. Three other patients had resection in the presence of metastasis to adjacent lymph nodes or local extension of the growth.

Thus, of the resected cases not known definitely to be palliative or unfavorable, only 6 were not followed for 10 years and 5 of these are known to have been living without recurrence 6 to 8 years after operation.

SUMMARY

The case histories of 81 patients who had resection for carcinoma of the colon 10 or more years ago were carefully reviewed. Of the patients with favorable lesions, that is, those in whom the adjacent lymph nodes were not involved and there was no local invasion of the surrounding tissues, 64.3 per cent survived 5 years without recurrence and 57.1 per cent are living and well without recurrence 10 or more years following resection of their malignant tumor.

Of the patients with unfavorable lesions, that is, those in whom the lymph nodes showed evidence of metastases or there was invasion of the surrounding structures by the tumor, 15 per cent were living and well 5 years after operation. Eleven per cent are living and well 10 or more years following resection (Table III).

The histories of 146 patients who had had a radical resection for carcinoma of the rectum or rectosigmoid 10 or more years ago were also reviewed.

In the favorable group (adjacent lymph nodes negative for carcinoma, no local invasion) 60 per cent were found to be well without recurrence at the end of 5 years; at the end of 10 years this figure had dropped to 51.6 per cent.

In the less favorable group (lymph nodes showing metastatic carcinoma or invasion of the surrounding tissues by carcinoma), 30.2 per cent survived 5 years without a recurrence. Only 23.2 per cent are living and well ten or more years following their operation (Table IV).

Of the patients who died from malignant disease between the fifth and tenth postoperative years, the majority died between 5½ and 6½ years following operation. Two patients lived 7 years and one 8 years. All of these patients gradually failed and died with the signs and symptoms of carcinomatosis of the abdominal cavity. Nevertheless, the possibility exists that some in this group may have succumbed to a second, undetected primary lesion arising in the gastrointestinal tract and not as the result of a recurrence of their resected lesion.

TABLE III.—CARCINOMA OF COLON

Group	Percentage of patients living and well for 5 years	Percentage of patients living and well for 10 years
Unfavorable (lymph nodes involved and local invasion)	15.0	11.0
Favorable (lymph nodes not involved)	64.3	57.1

TABLE IV.—CARCINOMA OF RECTUM AND RECTOSIGMOID

Group	Percentage of patients living and well for 5 years	Percentage of patients living and well for 10 years
Unfavorable (lymph nodes involved and local invasion)	30.2	23.2
Favorable (lymph nodes not involved)	60.0	51.8

CONCLUSIONS

These figures suggest that in a patient with carcinoma of the rectum, in whom the mesenteric lymph nodes of the resected specimens show no evidence of carcinoma, the prognosis is approximately twice as favorable as it is for a patient in whom the lymph nodes are positive. The unfavorable significance of positive lymph nodes in carcinoma of the colon appears even greater.

The figures also suggest that, although some patients who are living 5 years after resection for carcinoma of the colon or rectum will ultimately die of their disease, more than 50 per cent of those who survive this operation and in whom the mesenteric lymph nodes are negative for carcinoma may expect a permanent "cure" of their malignant disease from a radical surgical resection.

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CONGENITAL ATRESIA OF INTESTINE AND COLON

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THE outlook for newborn infants with congenital atresia of the bowel is not as black as it was 20 years ago. Up to that time a postoperative recovery was of sufficient rarity to be worthy of publication. Because of persistent work by those interested in children's surgery, Ladd and Gross, Miller, Donovan, Duckett, Webb and Wangensteen, and others, the mortality figures are constantly improving. The infant who does not come to surgery until the distended bowel has ruptured and produced a full blown peritonitis has little or no chance of survival. Likewise, the infant with multiple anomalies of the bowel or severe associated congenital malformations has a very slim chance of surviving surgery. The prognosis is good, however, for a full term infant who is normal except for atresia of the bowel, and who is operated upon the third or fourth day of life. Earlier diagnosis, chemotherapy, and the use of more appropriate suture material have contributed to a higher percentage of recoveries.

During the past 6 months, 5 patients with congenital atresia of the bowel have come under my care and have been operated upon: 1 of the duodenum, 3 of the ileum, and 1 of the colon. There was 1 death.

DIAGNOSIS

Little difficulty would be experienced in making a diagnosis if congenital atresia of the bowel were more common. However, many physicians in general practice never encounter this condition in a lifetime of active practice. Even in the practice of a busy pediatrician few of these patients are seen. It is entirely pardonable that the diagnosis is not made until the symptoms of intestinal obstruction present themselves.

Vomiting is the outstanding early symptom. It begins the first or second day after birth, depending upon the level of obstruction, and is persistent. By the third day of life the vomitus is greenish brown and has a foul odor. The majority of atresias are below the ampulla of Vater and the vomitus contains bile. In Case 1 of this series the obstruction was above the ampulla.

Distention varies with the level of obstruction. In Case 4 of an infant with atresia of the colon there was tremendous distention, whereas the infant with atresia of the duodenum after deflation of the stomach had a scaphoid abdomen. Gastric peristaltic waves passing from left to right are seen in babies with duodenal atresia. Intestinal patterning is easily visible in patients with lower obstructions.

The difference in the stool of an infant with atresia of the bowel and that of a normal infant is recognizable but not impressive. It is light green, very small in amount, and contains mucus in contrast to the tarry appearance of a normal meconium stool. Farber's test is of value if uncertainty exists.

Roentgenologic examination is of great help in establishing the diagnosis (Figs. 2, 3, 4, 6, and 8). The roentgenogram should be made with the infant in the upright rather than the supine position. If obstruction is present, widely distended loops of bowel showing fluid levels will be seen. Furthermore, the x-ray film will indicate whether the obstruction is high or low. Positive differentiation of duodenal, ileal, or colonic obstruction is impossible because of the enormous dilatations seen and because these loops crowd one another into abnormal positions. The administration of barium to these babies is condemned. Its use is unnecessary to make a diagnosis of obstruction, it clogs the intestine and if aspirated tends to produce pneumonia.

A general physical examination is important primarily as a search for other abnormalities. A rectal examination is in order to determine patency.

PREOPERATIVE CARE

Parenteral fluid is essential for these infants who usually are admitted in a state of

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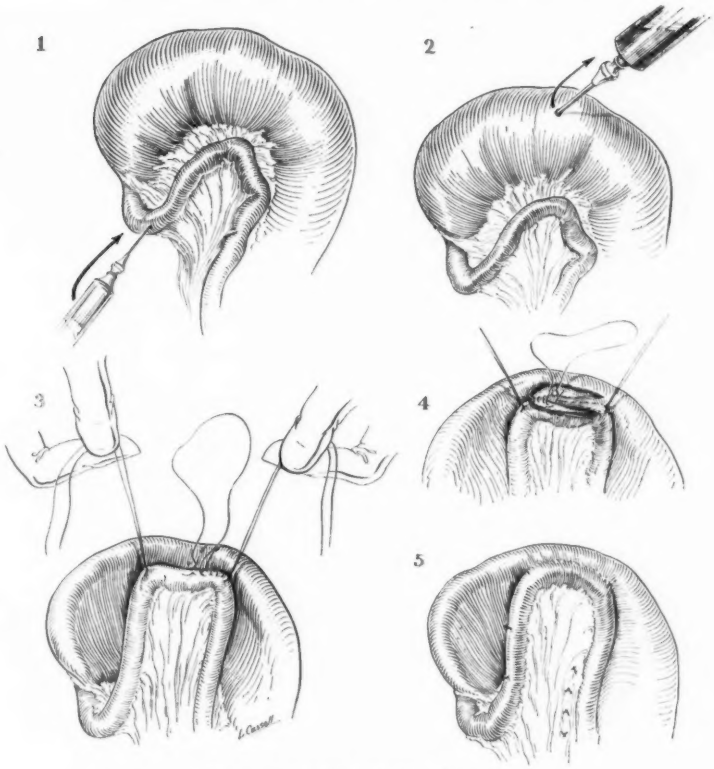

Fig. 1. Operative technique (see text).

moderate dehydration. Fluids can be given most satisfactorily by the intravenous route with a cannula in the saphenous vein at the ankle. A "cut down" is always necessary for insertion of the cannula. Administration of fluid by "marrow infusion" with a Tocantin needle may be used but is inferior to the intravenous method. Isotonic solution of saline 10 to 15 cubic centimeters per pound of body weight each 24 hours is sufficient. Dextrose solutions in 5 to 10 per cent concentrations should be used to bring the total fluid intake for 24 hours up to 50 to 75 cubic centimeters per pound of body weight. The fluid is begun preoperatively and continued postoperatively. Small blood transfusions, 50 to 75 cubic centimeters and plasma are used as indicated.

The stomach must be completely emptied before operation. A No. 10 F. catheter is inserted into the stomach through the nose and all fluid removed by suction with a syringe. If this material in the stomach is thick, or if the infant has been given barium, lavage may be necessary with a measured amount of water all of which is removed. The catheter is left in place during operation and postoperatively is attached to a Wangensteen suction apparatus.

OPERATION

Drop ether with an open mask is most satisfactory. A longitudinal right rectus muscle splitting incision is made sufficiently long to allow for adequate exposure. The greatly distended loops of bowel are allowed to escape from the abdominal cavity. There will be far less trauma to the fragile bowel wall if it is allowed to protrude as it will and is covered with moist packs.

The collapsed, undeveloped bowel, distal to the obstruction, is ordinarily the size of an old-fashioned slate pencil (Fig. 5). It is followed downward in a quick search for other points of atresia. Then with a fine hypodermic needle, salt solution is injected into its lumen just beyond the site of atresia to demonstrate other points of obstruction that may have been overlooked. If the fluid can be followed to the rectosigmoid patency has been demonstrated. A large caliber needle attached to a 50 cubic centimeter syringe is inserted into the distended bowel at a point where the incision is to be made later for the anastomosis. Aspiration of the air and meconium allows the thin bowel wall to collapse, makes the anastomosis easier and lessens the danger of leaks through needle punctures.

A side-to-side anastomosis is done between the proximal and distal loops (Fig. 1). Whether the anastomosis is made isoperistaltic or antiperistaltic seems to make little difference. The loops of bowel are apposed by two interrupted stitches of silk, one at each end of the site of the proposed anastomosis. These sutures are used to steady the loops of bowel while serosa is sewed to serosa with a continuous over and over silk stitch. No. 00000 Deknatel braided silk on a curved No. 9 atraumatic needle is the suture material of choice. The fact that the swaged-on needle is very fine, almost the same size as the silk, minimizes the danger of suture leakage. A fairly long cut is made in each loop of bowel. Mucosa is sewed to mucosa with a running over and over stitch of No. 00000 silk or No. 0000 chromic catgut on an atraumatic needle. It is judicious to take small bites of the bowel wall in each stitch lest the lumen be encroached upon. It is my feeling that a running, over-and-over suture carefully placed gives a better seal than interrupted stitches and that it interferes less with the blood supply than the Connell type of mattress suture. A second interrupted silk stitch at each angle re-enforces and completes the anastomosis. The opening in the mesentery is closed.

If multiple atresias exist the intervening segments may or may not be resected depending upon the condition of the patient. If left they will eventually produce sausage-shaped cysts requiring removal.

Usually a transfusion of 40 to 60 cubic centimeters of citrated blood is given during the operation.

The operative wound in each instance is closed with No. 000 chromic catgut for the peritoneum and posterior sheath of the rectus. The anterior sheath of the rectus is closed with interrupted No. 0000 Deknatel silk sutures.

POSTOPERATIVE CARE

Upon return to its crib the infant is given 50,000 units of penicillin followed by 10,000 units every 3 hours thereafter. A Wangensteen suction apparatus is attached to the catheter in the stomach immediately after operation and suction continued for 48 hours. Every 4 to 6 hours the catheter is irrigated or the infant is given a little water by mouth with a medicine dropper to be sure that suction is being maintained. The necessary amounts and types of fluid are continued intravenously. On the third postoperative day the catheter and suction apparatus are removed and the routine postpyloric regimen of feeding is begun. It is very important to underdo rather than press the amounts of food given. In Case 2 overfeeding necessitated resumption of gastric suction for 48 hours. By the seventh to fourteenth day, if all goes well, the infant is usually on a maintenance diet.

CASE REPORTS

CASE 1. J. B., a baby girl, was born May 26, and referred to The Children's Memorial Hospital by Dr. Edna Mortimer of Joliet, Illinois. The infant, 1 month premature, weighed 5 pounds 7 ounces at birth and 4 pounds 12 ounces upon admission. Physical examination revealed a tiny somewhat dehydrated infant with small mongoloid eyes deeply jaundiced. X-ray examination by the roentgenologist, Dr. Anspach revealed: "Films made with the patient in the upright position show two large fluid and air containing pockets typical of high obstruction of the duodenum" (Fig. 2).

Operation. The stomach and first part of the duodenum proximal to the ampulla of Vater were greatly distended; the rest of the bowel was tiny and collapsed. Since the duodenum extended directly inferiorly its third portion could easily be raised for anastomosis to the first portion. This was accomplished by two rows of continuous silk sutures. Immediate postoperative condition was good. The child was placed in oxygen for 48 hours. On the second postoperative day continuous feedings were begun, well tolerated and retained. Normal bowel move-

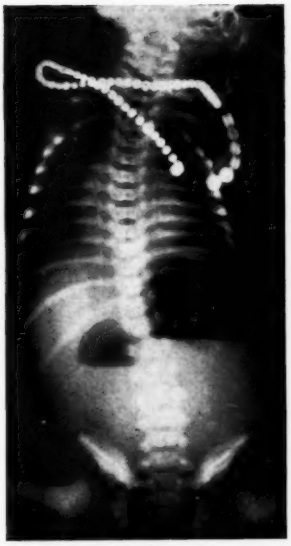

Fig. 2a.

Fig. 3.

Fig. 4.

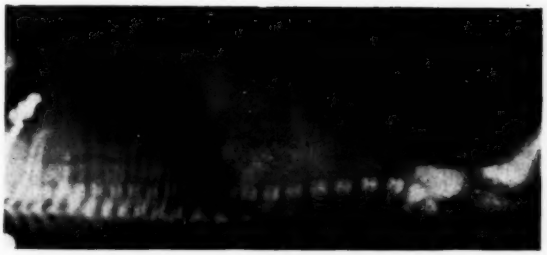

Fig. 2b.

Fig. 5.

Fig. 2. Case 1. a, Anteroposterior upright roentgenogram showing air bubble in stomach and duodenum; b, lateral supine view. Typical findings in atresia of the duodenum.

Fig. 3. Case 2. Loops of dilated bowel typical of atresia of the small intestine.

Fig. 4. Case 3. Roentgenogram shows loops of dilated small bowel.

Fig. 5. Case 3. Characteristic findings at operation—single atresia of the ileum.

ments were passed. For 6 days the infant did well even gained a little weight and then died suddenly. Postmortem examination revealed no demonstrable cause of death. There was a patent foramen ovale, a few petechial hemorrhages in the lungs and some congestion of all the organs. The duodenoduodenostomy was intact and in the normal process of healing. The presumptive cause of death was suffocation.

Case 2. K. M., a baby girl, was born June 25 and referred to The Children's Memorial Hospital June 30 by Dr. Ina Harper of Benton Harbor, Michigan. The infant's weight at birth was 6 pounds 8 ounces; upon admission 5 pounds 11 ounces. She had vomited all feedings since birth and had passed no meconium. Her general condition was fair and a good state of hydration had been maintained. Her abdomen was distended and intestinal patterning was visible. An x-ray film of the abdomen revealed distended loops of small bowel containing barium. Diagnosis was congenital atresia of the small bowel (Fig. 3).

Operation. An enormously dilated, bluish purple but not gangrenous ileum was exposed. The obstruction was single about 6 inches proximal to the ileocecal valve. A side-to-side antiperistaltic anastomosis was done with two rows of continuous silk sutures.

The infant passed tarry meconium the first postoperative day. We disregarded our own advice to underfeed these infants. Abdominal distention and vomiting on the eleventh postoperative day necessitated the reinstitution of continuous gastric lavage

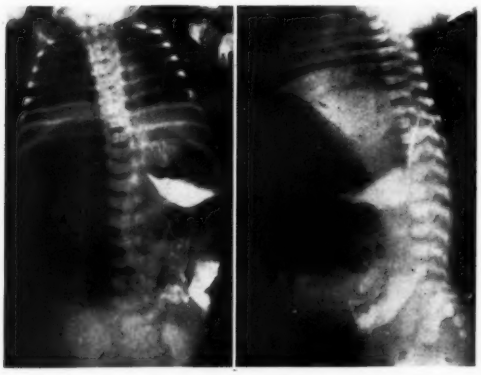

Fig. 6. Case 4. Anteroposterior and lateral roentgenograms showing tremendous dilatation of the ascending colon.

and parenteral fluids for 48 hours. Feedings were then begun cautiously and were well retained. The infant was discharged in good condition on the twenty-second postoperative day.

CASE 3. F. S., a baby boy, was born August 1 and referred to The Children's Memorial Hospital August 5 by Dr. Eugene T. McEnery. His weight at birth was 6 pounds 5 ounces; upon admission 6 pounds. The infant had vomited persistently since the second day after delivery. His general condition was good. The abdomen was distended and showed intestinal patterning. X-ray examination revealed distended loops of bowel with fluid levels (Fig. 4). Diagnosis was congenital atresia of the small bowel.

Operation. Single atresia of the ileum was found 2 inches above the ileocecal valve (Fig. 5). An isoperistaltic side-to-side anastomosis was done about the obstruction using No 00000 silk on the serosa, and No. 0000 chromic gut on the mucosa. The child made an uneventful recovery, and was discharged on the eighteenth postoperative day.

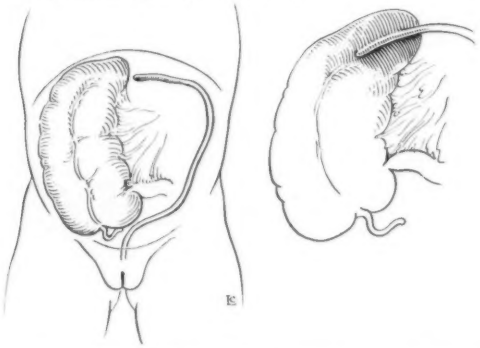

Fig. 7. Case 4. Diagrammatic illustration of operative findings in congenital atresia of the transverse colon.

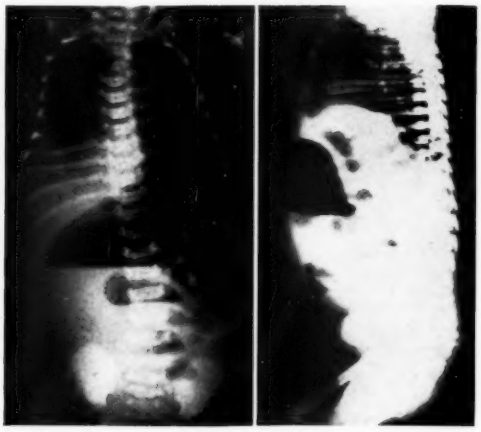

Fig. 8. Case 5. Anteroposterior and lateral roentgenograms showing huge dilatation of the small bowel in congenital atresia of the ileum.

CASE 4. B. M., a baby girl, was born August 22, and was referred to The Children's Memorial Hospital August 25 by Dr. John A Bigler. Her weight at birth was 7 pounds 8 ounces; upon admission 6 pounds 15 ounces. Persistent vomiting had begun 48 hours after delivery. Upon admission the abdomen was greatly distended and tympanitic. X-ray examination revealed a collection of air and barium containing fluid in the right half of the abdomen (Fig. 6). This was erroneously interpreted by us as a rupture of the bowel because it seemed impossible that dilatation to such size could occur without rupture. Preoperative diagnosis was congenital atresia of the ileum with rupture. Postoperative diagnosis was congenital atresia of the transverse colon without rupture

Operation. When the abdomen was opened the unruptured, ascending colon delivered itself from the wound. Complete atresia of the transverse colon was found just beyond the hepatic flexure. The distal colon was patent. The ascending colon resembled a toy balloon; the transverse and descending colon a long angleworm. A side-to-side isoperistaltic ana-

Fig. 9. Case 5. Operative findings. The tip of the forceps indicates the second point of atresia demonstrable only after injecting the bowel with salt solution.

stomosis was done using No. 00000 silk throughout (Fig. 7). The postoperative course was singularly smooth. On the nineteenth postoperative day a barium enema demonstrated that the lumen of the colon had enlarged considerably. The infant was discharged in good condition on the eighteenth postoperative day.

CASE 5. J. P., a girl, was born October 13, and was referred to The Children's Memorial Hospital October 18, by Dr. Anders J. Weigen. She weighed 6 pounds 15 ounces at birth and 6 pounds 4 ounces upon admission. Vomiting had begun on the second day of life and persisted. The vomitus upon admission had a fecal odor. No bowel movement had been passed since birth. Hydration had been well maintained and the infant's general condition was surprisingly good. X-ray examination revealed an enormous dilatation of the small bowel (Fig. 8).

First operation. October 18, 1946. Atresia of the ileum at approximately its midportion was found. Injection of salt solution into the ileum distal to the obstruction revealed a second atresia about 8 inches from the first (Fig. 9). It had not been seen upon exploration. This 8 inch section of bowel was removed and the ends turned in with interrupted silk sutures. A side-to-side isoperistaltic anastomosis was done, using No. 00000 silk for the serosa, and No. 0000 chromic catgut for the mucosa. During and immediately following the operation, 75 cubic centimeters of citrated blood was given. Postoperatively the child did well for 9 days. Then distention and vomiting recurred, and persisted in spite of continuous gastric aspiration.

Second operation. November 1, 1946. The previous incision was opened, and a generalized subsiding peritonitis was found. Large collections of yellowish turbid fluid were aspirated. The loops of bowel were plastered together with masses of plastic exudate. There was no odor. Exposure to the anastomosis did not seem justified because of the amount of trauma it would entail. The abdomen was closed without drainage. Streptomycin, 50,000 units every 3 hours, was started postoperatively, along with 10,000 units of penicillin which the infant has been receiving since the first operation. A number of bowel movements were passed and feeding again cautiously begun. For a week the infant did well. Distention recurred and again continuous aspiration of the stomach failed to relieve it.

Third operation. November 15, 1946. The old incision was reopened but in spite of care a hole was made in the distended bowel adherent to the anterior abdominal wall. The hole in the bowel was closed with interrupted silk sutures. Exploration revealed obstruction, cause undetermined, at the site of anastomosis. A side-to-side antiperistaltic anastomosis was made about the previous one and the abdomen closed. The third postoperative course was uneventful. Small feedings started on the third day following operation were retained and well tolerated. At the time of writing the infant is taking a generous diet and is gaining weight.

CONCLUSIONS

Earlier diagnosis, chemotherapy, proper suture material, and physiological preoperative and postoperative care have improved the outlook for infants with congenital atresia of the bowel.

Five cases of atresia of the bowel with 1 death are reported.

Review of medical literature indicates that the patient with congenital atresia of the transverse colon included in this report is the first to survive surgery.

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DOUBLE CLEFTS OF THE LIP

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THE surgical repair of double cleft lips is about twice as difficult as in single clefts and the results are about half as good. Nevertheless, enough slow progress has been made to be worth recording and to note procedures or details to avoid.

Normally, the frontonasal process of the embryo fuses with the two lateral maxillary processes by the ninth week. When there is total lack of fusion of these on both sides, the three processes develop independently of each other from the ninth week until term, with the result that the baby has not only a hiatus or cleft on either side, but also has severe growth distortions of the entire middle third of the face. Partial fusion on one side makes this distortion asymmetrical on the two sides and may render the interpretation and plan for repair even more difficult.

Many of the surgical principles and operative details outlined in previous papers on single cleft lips (1, 2) are applicable in double clefts and will be referred to frequently. The double clefts, however, vary a great deal more in the amount and shape of the deformity, so that more individual study and improvising is necessary in planning their repair. They are not considered surgically simply as two single clefts, both of which happen to occur in the same patient.

AGE FOR PRIMARY OPERATION

The child with a double cleft lip has a very difficult feeding problem, produces much psychic shock to the parents, and incites so many exclamations of curiosity and pity from others that an early closure is necessary (Figs. 1–6). It may be true that nicer closures could be obtained in *some* of these patients with less difficulty by waiting (Figs. 13, 14), but the situation in general is almost intolerable for both the parents and the child. The operation is one of considerable magnitude, though, and they are not closed as early as single clefts. A fairly satisfactory rule is to close them as soon as possible after the baby weighs 10 pounds, subject to variations in the extent of the deformity and the child's general physical condition. Many of these patients have an anemia and are given transfusions to bring the preoperative hemoglobin up to 12 to 15 grams per cent. Nearly all of those with open palates will have a chronic otitis media which is not an especial contraindication to surgery. Operations are not done, of course, during an acute exacerbation.

Until the lip is closed, feeding is done with a syringe (with a short piece of rubber tubing attached) and gavaging is usually avoided.

TREATMENT OF THE PREMAXILLA

The premaxilla is the separate central segment of the upper jaw and is that portion arising from the embryonic frontonasal process. Briefly, the problem of the premaxilla is that it is nearly always too far forward in the newborn baby, but only with considerable effort can it be kept from being retruded too far backward in the adult. It varies a good deal in size, shape, and position, and at times, as to the number of tooth buds it contains (Fig. 7). The large oval, or almost rectangular, premaxilla forms a better central segment of the jaw supports the lip better, and will have the lateral incisor tooth buds inclined only slightly laterally, so that it is easier to work with for both the surgeon and the orthodontist. It overlaps the lateral processes slightly on both sides, so that if it is necessary to set it back, it will rest as a bridge on them and will not tend to tilt and cannot sink back behind them. The small, round, premaxilla may be smaller than the hiatus between the two lateral processes, so that one must try to prevent it from being forced back between and behind them, thus producing a retruded upper jaw and lip. The tooth buds are arranged in a partial circle around its periphery so that the lateral incisors

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Fig. 1. Partial double cleft shown just before operation (age 2 days) and at age of 3 years. Closed by plan marked in figure 9c. Good full vermilion obtained.

Fig. 2. Partial double cleft closed in same manner as in Figure 1. Note the amount of nostril rotation necessary on both sides. These clefts may be more difficult than total ones because they have less vermilion available for the repair.

may tend to grow directly into the lateral processes, or even up into the nostril floors, or forward through the lip if it becomes tilted. Some of the permanent tooth buds may be entirely missing from these tiny, round, premaxillae.

In the newborn baby, the premaxilla is nearly always anterior to the lateral processes. It may be anywhere from just in front of them to extreme positions out on the tip of the nose where it may project forward and upward like a snout. In addition to forward displacement, it may be tilted from side to side, or rotated. If the cleft is partially fused on one side, the premaxilla may be rotated toward that side, but tilted so the open edge is farther forward.

It is not uncommon to find a bend or kink in the septum just behind the premaxilla, sometimes so marked as to occlude one or both nasal airways at birth. This may be the result of intrauterine pressure on the premaxilla.

As a rule, the premaxilla is not disturbed or set back if the lip can be closed with it in its original position unless; (a) it is badly tilted or rotated or (b) it is so far forward that the elastic pressure of the closed lip might bend the septum and occlude one or both nasal airways.

If the premaxilla is to be set back, it is set back the least possible amount necessary to allow successful closure of the lip. This is done by splitting the mucosa over the bottom of the vomer and resecting a block (submucously) of the vomer just back of the premaxilla. The premaxilla is set back until it is in contact with the vomer again and immobilized by a

Fig. 3. Partial double cleft with severe initial distortion. Repair was done by a plan somewhat similar to that in Figure 9b, except that a small rectangular flap (Fig. 12) was used on one side to make the lip equal in length clear across.

Fig. 4. Total cleft on one side and partial cleft on the other. The design for repair was the same as in Figure 3, but it was necessary to rotate the nostrils a good deal more to straighten the columella and obtain the nostril symmetry shown in the final result. The premaxilla was not moved, except by the elastic pressure of the closed lip.

Fig. 5. Initial condition and repair much the same as in Figure 4, except that the patient had a very tiny prolabium which was stretched out considerably during the operation and grew still more during the next year. Notice the absence of notches or "whistling" defects in these patients where all of the vermilion has been procured from the lateral segments.

wire suture through both fragments or better by nailing a straight Keith needle directly backward through the center of the premaxilla and on back through the center of the vomer (Fig. 8). In setting the premaxilla back, an attempt is made to correct any rotation or tilting so that it will be centered with respect to the lateral processes as well as possible. This is insured somewhat by having excised a block rather than a wedge of the vomer.

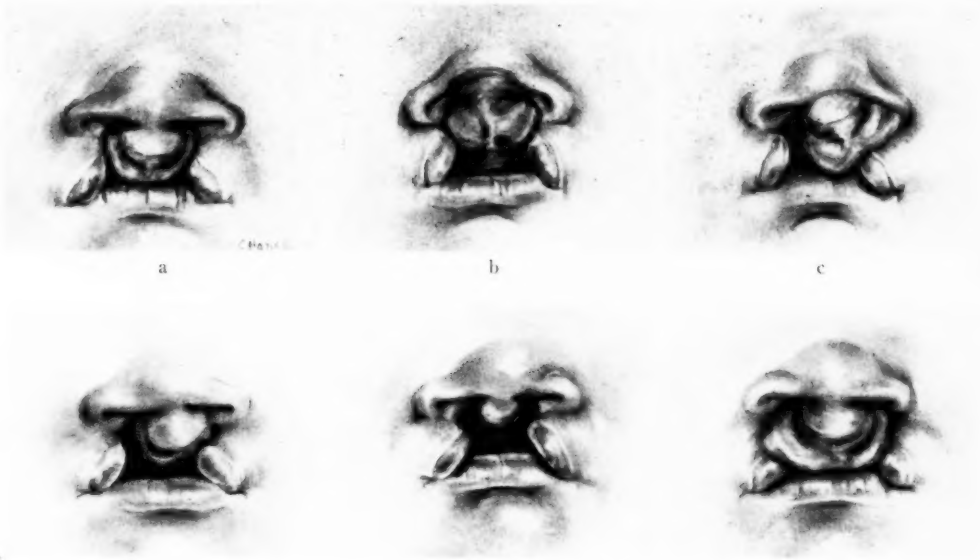
When the premaxilla is larger than the space between the two lateral processes, and good firm immobilization is obtained, the lip can be closed during the same operation; otherwise, the closure is done about 2 weeks later. Bony union between the premaxilla and vomer is rarely obtained either way, but the fibrous union helps a good deal in keeping it centered.

THE DISPOSITION OF THE PROLABIUM

The prolabium is the central segment of the lip and must be used in this position in the closure. The upper part of it is sometimes advanced secondarily into the columella at 3 or 4 years of age (3), but it is best not to do this primarily.

Many plans of closure have included the vermilion of the prolabium in the vermilion of the reconstructed lip, but these nearly always result in a double notch. This notching is not

Fig. 6. Total double cleft with almost no columella and with premaxilla projecting forward from tip of nose. Premaxilla set back and lip closed early in life and columella elongated at 3½ years of age by method shown in Figure 15. Upper lip maintained in front of the lower one and patient has perfect speech following closure of palate at age of 18 months.



a b c

d e f

Fig. 7. Drawings of patients showing some variations in shape, size, and position of premaxillae. These variations preclude standardization in the closure of double cleft lips to the same extent as in singles. a and f can be closed without moving the premaxillae. b requires a preliminary setback of the premaxilla. c requires a preliminary rotation and "nailing" of it in the midline. In d, the prolabium can be loosened slightly from the premaxilla and swung into the midline without moving the bone, a triangular or rectangular flap closure being used on the total side and a "V" excision on the partial side. e, The patient shown in this illustration will probably require closure with rectangular flaps from both sides to elongate the lip as shown in Figure 12.

Fig. 8. When the premaxilla is too far forward to permit closure of the lip, it may be set back by submucous excision of a block of bone from the vomer. This removal of a block, rather than a wedge, permits the pushing of it directly back like closing a drawer, rather than tilting it back. This factor is of some advantage, as the finished lip should slant forward in the profile view from above downward. At right the premaxilla is being set back until it rests as a bridge on the two alveolar processes. It is anchored by means of a straight steel needle which is driven through the center and on back through the bony ridge at the bottom of the vomer.

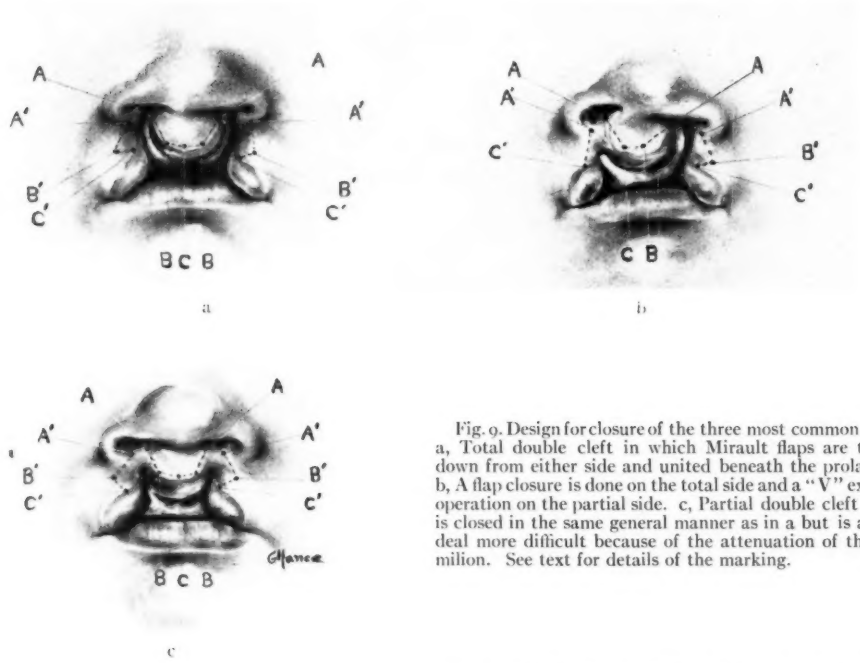


Fig. 9. Design for closure of the three most common types. a, Total double cleft in which Mirault flaps are turned down from either side and united beneath the prolabium. b, A flap closure is done on the total side and a "V" excision operation on the partial side. c, Partial double cleft which is closed in the same general manner as in a but is a good deal more difficult because of the attenuation of the vermilion. See text for details of the marking.

Fig. 10. An incision is made in the buccal fornix on either side and undermining is carried upward almost to the orbital borders until the cheeks have been separated from the underlying facial bones. The mucosal incision is then carried forward in the nostril between the upper lateral and alar cartilages, and the skin is separated from the alar cartilages with small scissors. The latter maneuver allows the skin to slide on the cartilage and the nostril to be rolled into a tube without corrugation.

easy to eliminate by secondary procedures as it is due to an inherent thinning and upward direction of the vermilion on both sides of the prolabium

Consideration of the "cupid's bow" configuration of some normal lips has somewhat confused this issue. The occurrence of the "cupid's bow" varies a good deal in normal lips and in any event it is an upward prolongation of the *upper* edge of the vermilion beneath each philtrum. The lower edge of the normal vermilion has a gradual downward curve from the center outward without any upward notches, and it is almost impossible to get this when the thin "U-shaped" vermilion of the prolabium is used as the central portion of the new lip.

It is thought best to use a plan in which an incision is made at the mucocutaneous junction all the way around the prolabium and its vermilion is turned back as a flap to be used for lining if necessary.

DESIGN FOR CLOSURE

Many of the features of the modified Mirault operation for single cleft lips (1, 2) are used in

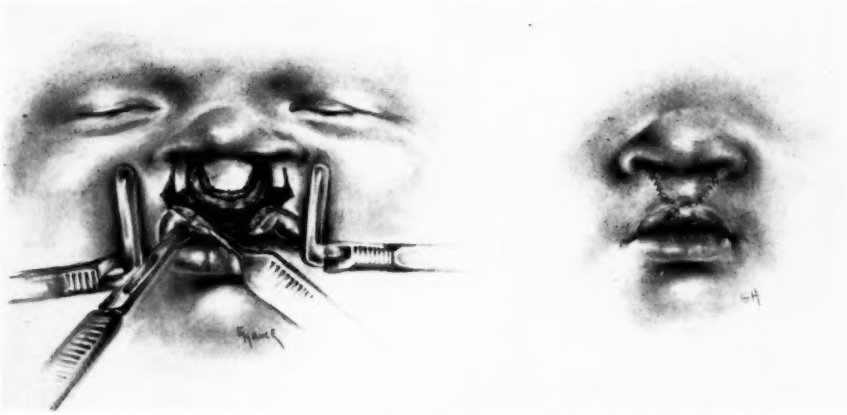


Fig. 11. a, left, Crile clamps are placed to prevent bleeding and both sides of the lip are opened up, going completely through the lip with a stab blade knife and using a perpendicular sawing motion. Any skin remnants are sliced off of the vermilion flaps. The vermilion of the prolabium is cut loose from the skin and turned back all around. b, The closure is done with many fine silk sutures, put in not more than 1 to 2 millimeters from the wound edges and about as far apart. Any stay sutures are put in from the inside and are not visible. The vermilion is closed by interdigitating small flaps.

Fig. 12. Design for closure when a tiny prolabium is present. Rectangular flaps are turned down from either side and united beneath the prolabium to increase the length of the lip. In general, a full short lip is preferable to a tight long one, so that this design should only be used when the prolabium is quite short from above downward.

closing the double cleft lips. Usually a flap is turned down from the inner surface of the lateral border of the cleft on each side, and they are brought together in the midline beneath the prolabium (Fig. 9c). If the cleft is partial on one side and total on the other side a "V" excision operation may be used on the partial side and a Mirault flap on the total side (Fig. 9b). When the prolabium is unusually large and long, so that the Mirault flaps under it might result in too long a lip, 2 or 3 millimeters of skin can be excised from the bottom of the prolabium to shorten it. If the prolabium is tiny, the lateral flaps may be designed in a rectangle (rather than a triangle) to elongate the lip (Fig. 12).

In marking out symmetrical clefts with the columella in the midline, a transverse line is imagined across the prolabium at the level of the base of the columella, and the points *A*

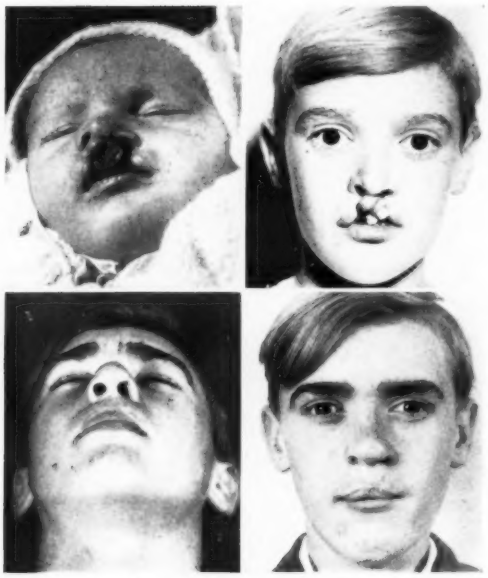


Fig. 13. Initial repair at the age of 10 years. The psychological handicap was very great and will probably never be entirely overcome. As a matter of fact, he called for a mirror as soon as he had awakened from the anesthetic, and kept it constantly under his pillow so that he could reassure himself several times daily that his dream had come true and that he was really going to be like other children.

are marked on either side where this line crosses the mucocutaneous junction. A' is marked just inside the lower point of the nostril rim on each lateral side of the cleft, being careful to place it in such position that a good nostril will be formed when A' is approximated to A, and marking it symmetrically on the two sides (Fig. 9).

The point C is at the bottom of the skin of the prolabium in the midline and equidistant from the two A points. B is $\frac{1}{3}$ of the distance from C back to A on the curved lower border of the skin of the prolabium on either side.

C' is on the mucocutaneous line of the lateral part of the lip and is opposite the most medial point where there is still full thickness of the vermilion.

To locate B', the straight line distance AB is measured with small calipers. One point of the calipers is then set on A' and the calipers rotated until the other point is BC distance from C'.

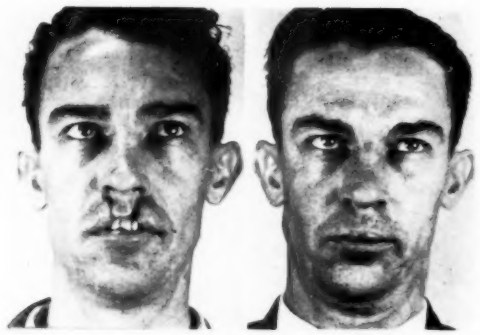


Fig. 14. Initial repair at the age of 32 years. Though the palate was not cleft, patient has so much forward protrusion of the incisor teeth that it was thought best to remove them and substitute a bridge.

The above can be considered as a standard marking and can be altered when necessary. For instance, when the cleft is partial on one side, the line $A'B'C'$ is sometimes a straight one, so that B' can be omitted and a straight incision made from A' to C' and a "V" closure done on that side (Fig. 9).

THE CLOSURE

The above points are punctured in and the lines scratched in with 5 per cent alcoholic methylene blue, using a fine mechanical drawing pen. The lines are then lightly incised with a knife, with care not to cut the points out. An incision is then made in the buccal fornix on each side and carried upward to separate the lip from the upper jaw (Fig. 10). This undermining is carried upward almost to the orbital border until the cheek is separated from the underlying facial bones, and the space between them is packed temporarily with gauze soaked in 1:5,000 adrenalin solution.

The buccal fornix incision is then carried upward inside the lateral wall of the nostril to divide the mucosa between the upper and lower lateral cartilages of the nose until the nostril can be rotated into position and A' can be brought over to A without tension. A small fine scissors is introduced through the buccal fornix and the lower lateral cartilage of the nostril is separated from the skin covering by alternate spreading and dissecting up to the midline (Fig. 10).

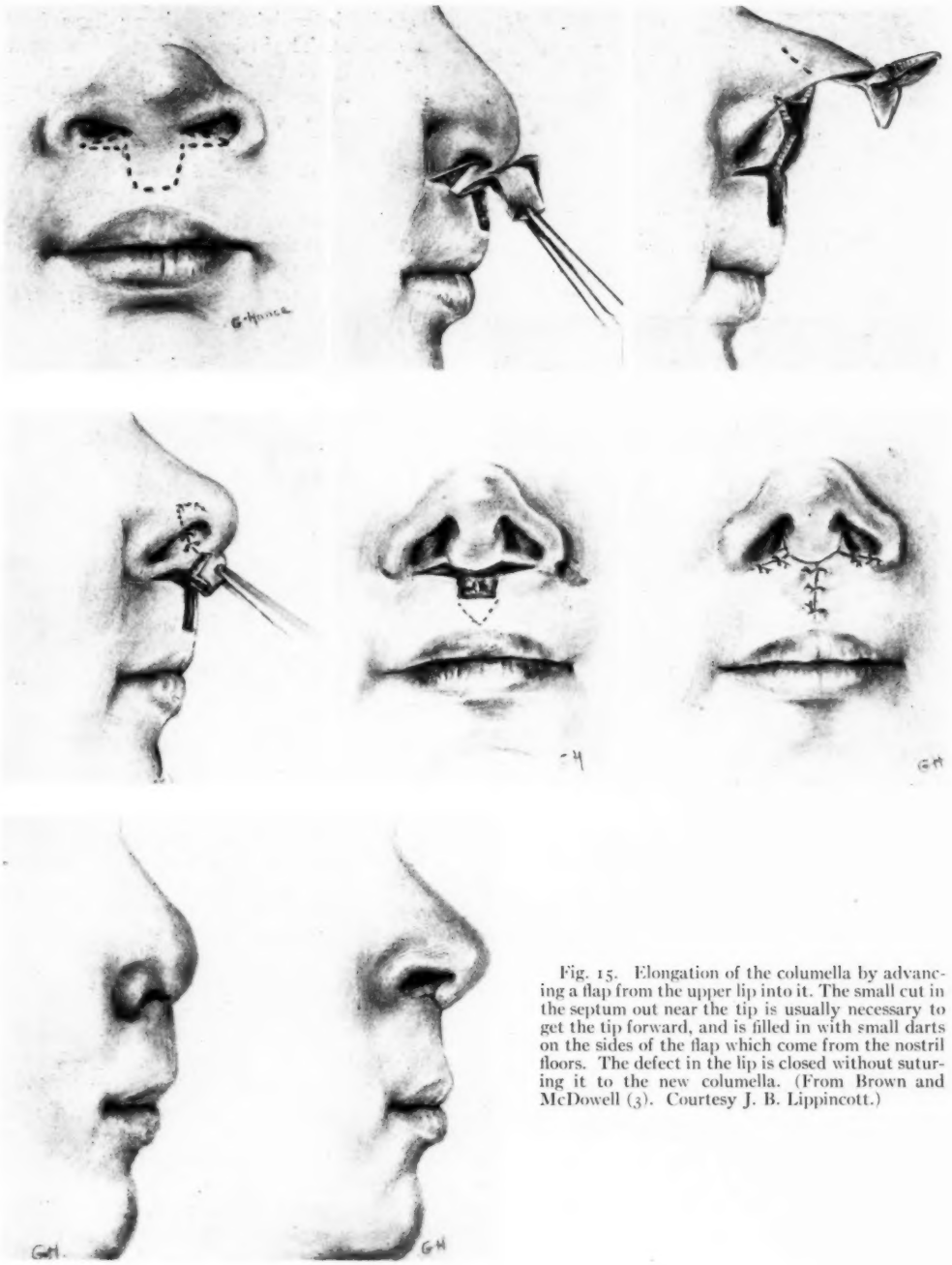


Fig. 15. Elongation of the columella by advancing a flap from the upper lip into it. The small cut in the septum out near the tip is usually necessary to get the tip forward, and is filled in with small darts on the sides of the flap which come from the nostril floors. The defect in the lip is closed without suturing it to the new columella. (From Brown and McDowell (3). Courtesy J. B. Lippincott.)

Fig. 16. Total double cleft similar to that shown in Figure 6. Closure was done during the first days of life, the columella elongated at about 3½ years of age, and a preserved "L-shaped" cartilage transplant inserted into the nose at the age of 6 years with the improvement shown from left to right. Many of these patients who are born without a columella have a deficiency in the septal support of the nose. (Insert shows shape of the transplant.)

The lines $A'B'C'$ are then incised through the full thickness of the lip, a stab blade knife being used with a perpendicular sawing motion (Fig. 11). The small flap $A'B'C'$ is rotated 180 degrees into the nostril floor. The vermilion of the prolabium is turned backward as a flap to use for lining and A–A' and B–B' are approximated on both sides, No. 000 white silk sutures being used subcutaneously and No. 000 black silk sutures in the skin. C'–C' are approximated directly under C and fine interrupted black silk skin sutures are placed all along between A–B–C. The vermilion closure is done by interdigitating zigzag flaps from the two sides. The inside mucosa from the two sides is sutured to the prolabium vermilion which was turned back. The nostril floor flaps are trimmed and sutured to the portion of the prolabial skin inside the nostrils, and mattress sutures are put through the nostril walls to aid in shaping them. Stay sutures may be put clear across the lip from the inside, encompassing the full thickness of the lip except the skin, to avoid any visible suture marks on the outside. (The type described by Lane is a good one.)

A Logan bow is strapped to the cheeks to protect the lip and take tension off of it while crying, and the nurses keep the suture lines free of crusts by frequent cleansing. The skin sutures are left in 5 days and the others a few days longer. The baby can usually be fed with a bottle after the first week, if the holes in the nipple are enlarged, and the child is discharged from the hospital after all sutures are out.

Any surgery on the palate is delayed until about 18 months of age to permit the tooth buds to migrate out of the palate into the alveolus.

The possibility of secondary procedures (3) on the lip is considered from the beginning with the parents, but they will be fewer in number and less in extent if the primary closure is a good one.

Those children who are born with a total double cleft and almost no columella will frequently require a secondary elongation of the latter (Fig. 15) so that this may be considered standard in this type of patient. Further elevation of the nose may be obtained, when desirable, by an "L-shaped" cartilage transplant (Fig. 16).

Maintenance of the size and structure of the upper dental arch is important in these patients for lip support, as well as for other reasons. The child's dentist is contacted early so that proper dental hygiene may be instituted, and he may help later in providing or securing adequate orthodontic care. Limited prosthodontia may eventually be necessary in patients with total clefts.

In addition to dental care, those children who have associated palate clefts may require the assistance of speech therapists and otolar-

yngologists. Tonsillectomies and adenoidectomies should not be done routinely, but they may be carried out if necessary for reasons of general health, or especially if the tonsils and adenoids are contributing to any loss of hearing.

The plastic surgeon can render an additional service if he will examine these patients each year throughout the growing period and advise the parents in regard to these problems as they arise. Though starting with a severe initial handicap, these children often prove to be brighter than average and succeed so well in later life that one feels well repaid for the extra time and effort required in providing the best possible care for them.

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TRANSPLANTATION OF THE URETERS INTO THE RECTOSIGMOID

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CONGENITAL or acquired disease of the urinary bladder may render it incapable of performing its function as a reservoir for collecting the urine and emptying it periodically. The congenital type most frequently seen is extrophy of the bladder (ectopia vesicae). In this anomaly local arrest of growth occurs and the child is born with a defect in the lower anterior abdominal wall. The posterior wall of the bladder is seen as a strawberry-like swelling in the suprapubic area. Examination of this strawberry-like bulge reveals two small openings on either side through each of which urine is jetted at regular intervals. There is often an associated anomaly of the urethra and other genital organs. Many of the patients die in early childhood from ascending infections to the kidneys or from other congenital defects that are not compatible with life. It occurs according to Spooner 4 times in every 116,000 births; according to Neudoerfer, once in 50,000 births. Approximately 50 per cent of all persons so afflicted are dead by the tenth year of life.

Injury to the bladder may be the result of difficult and prolonged labor. The bladder and the vesical sphincter as well as the vagina may be lost by pressure necrosis. Such patients are frequently admitted to the hospital with a history of a long and difficult labor terminating in instrumental delivery or spontaneous delivery of a macerated fetus. When the tissue loss is great, plastic repair is impossible and ureterosigmoidal transplant is the only operation that will restore continence. In other cases, the damage to the bladder is the result of accidents or bullet wounds, resulting in complete or almost complete destruction of the bladder and sphincter. In most of these cases, where tissue loss is great, improvement cannot be secured by plastic operations.

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Very early the idea was suggested of establishing continence in these patients by surgically producing a cloacal condition such as exists in birds. According to Mayo the first attempt at such an operation was made by Simon in 1851. In 1896 Maydl transplanted an inverted portion of the bladder wall with the ureters attached into the sigmoid. Moynihan in 1906 performed an extraperitoneal operation in which he inverted the large part of the bladder into the anterior wall of the rectum. To Coffey must go the credit for laying down the principles which have given an anatomicophysiologic clarification of the surgical probblems involved. He attracted attention to the fact that when a duct opens into a cavity to discharge its contents, it runs in its terminal part through the wall of the viscera and then opens into its lumen. The terminal part of the duct is intramural in relation to the cavity into which it opens. This is illustrated by the salivary ducts opening into the mouth, the common bile duct opening into the second part of the duodenum, and the ureters opening into the bladder. This anatomical relationship provides a sphincter mechanism and prevents regurgitation of urine into the ureters. Coffey, therefore, transplanted the ureters into the rectosigmoid by burying the terminal parts into the wall of the sigmoid and the very end of the cut ureter into the lumen of the sigmoid. In 1926 Mayo reported 66 cases of operations carried out by the Coffey technique in which 48 patients were said to have obtained satisfactory results. These operations were done in two stages. In most of his cases a ureteral catheter was used and kept *in situ* for a few days after the operation to prevent obstruction of the ureters. These catheters had one end inside the ureter and the other was brought out of the anal opening. The operation, however, was improved by Mr. Henry Wade of Edinburgh, who used a modified Coffey-Mayo technique. Mr. Wade transplanted both of the

Fig. 1. Incisions are made through the posterior parietal peritoneum exposing the ureters. Ureters divided at the ureterovesical junction and a rubber band tied proximal to the cut end preventing spill. Clamp is passed behind the left mesosigmoid and the left ureter is brought through the mesosigmoid before implantation.

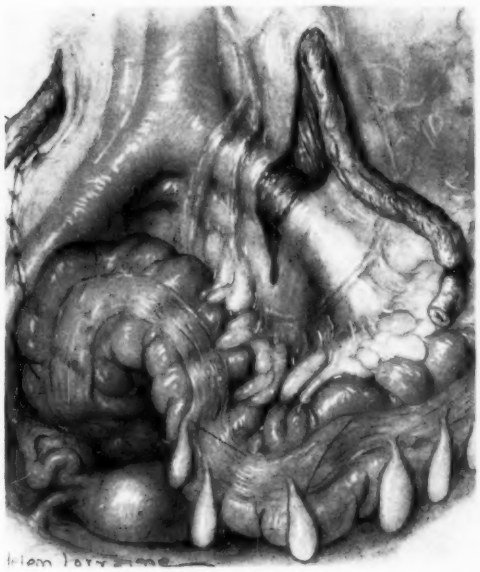

Fig. 2. After the left ureter has been drawn through the mesosigmoid it is now possible to perform the implantation without kinking.

ureters into the rectosigmoid at one operation, and he did not make use of the ureteral catheters. Instead, he left a wick of catgut inside the ureter to prevent its closure.

At the American University Hospital we have, during the last 6 years, transplanted the ureters in 19 patients. We have used Mr. Wade's technique with changes which are believed to offer certain advantages.

TECHNIQUE OF OPERATION

Thirty-six hours before the operation the patient is given a purge of castor oil. Following this she is put on a fluid diet consisting of water, tea, and lemonade. If her fluid intake is not sufficient, she is given fluids in the form of infusions or hypodermoclyses of 5 per cent glucose in saline. The morning of the operation she is given enemas until the return is clear. An injection of morphine and atropine is given 45 minutes before the operation. Ether inhalation anesthesia is used. When fully anesthetized, the patient is put in Trendelenburg's position.

A midline infraumbilical incision is used. The right ureter is first identified as near the bladder as possible and the peritoneum over the ureter is incised. The ureter is dissected free for a distance of about 15 centimeters, care being taken to leave the periureteral and the ureteral vessels attached to the ureter. A ligature is placed on the ureter as near to the bladder as possible. The ureter is then cut above the ligature with a scalpel (the crushing effect of scissors is avoided), isolated for the

Fig. 3. Longitudinal incision, 1 centimeter long, divides the cut end of the ureter and the flaps everted with a suture of No. 0 plain catgut.

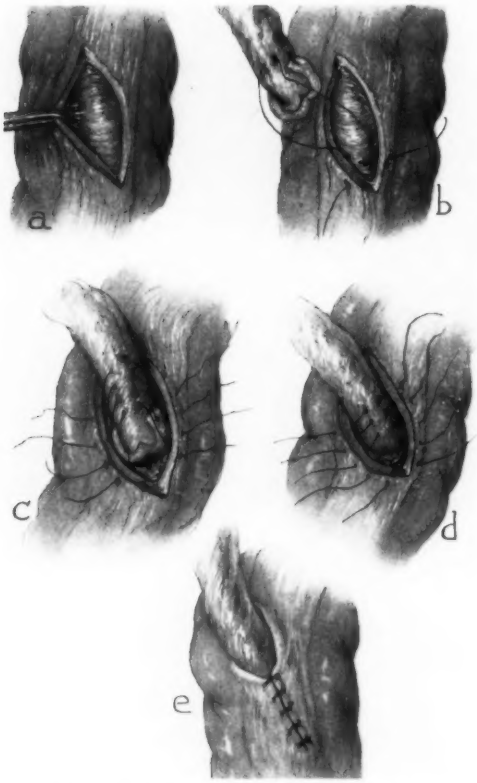

Fig. 4. a, Incision down to the muscularis; b, chromic No. 1 suture through peritoneal flap, periureteral tissue and out through the opposite flap; c, additional supporting sutures similarly placed; d, mucosa of bowel opened with hot cautery and sutures tightened, which brings the everted end of the ureter into the bowel lumen; e, sutures tied, anchoring the ureter and approximating the peritoneal covering of the bowel.

appropriate length with the periureteral tissues and lifted into the abdomen. A rubber band is placed around the ureter 2 centimeters proximal to the cut end to prevent spill and to prevent bleeding from the divided ureteral vessels. The divided peritoneum is sutured.

The left ureter is similarly exposed. On the left side, however, an artery clamp is passed along and parallel to the ureter behind the pelvic colon to the root of the mesentery where the clamp is forced through the mesentery of the sigmoid. The end of the divided ureter is caught by the point of the clamp and pulled

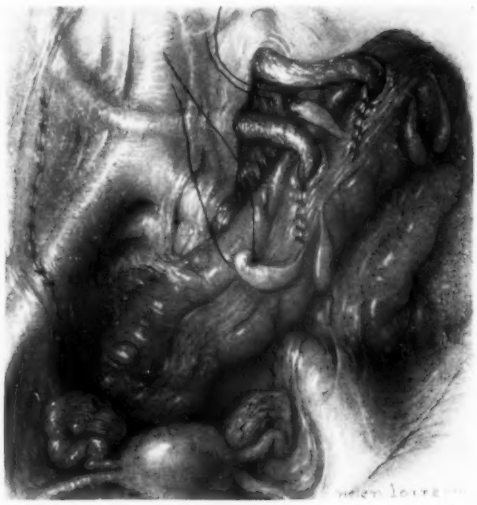

Fig. 5. No. 1 chromic sutures are passed through the fascia of the left psoas muscle and the appendices epiploicae and upon tieing the sigmoid is rotated so that the points of implantation are immobilized in the retroperitoneal space.

up so that it is above the pelvic colon (Fig. 1). The left ureter is now anterior (Fig. 2).

Two longitudinal slits are made in the cut ends of the ureters (Fig. 2) and the flaps turned upward like cuffs and held in place by a stitch of plain catgut (Fig. 3).

The pelvic colon is chosen for the site of the implantation, the left ureter being implanted high and the right, lower down. It is best to use the tenia of the colon for the site of implantation. This is incised obliquely for a distance of ¾ inch, and flaps of serosa muscularis are turned out without opening the bowel mucosa. The distal portion of ureter is laid in this bed, and the peritoneal flaps sutured over the buried portion of the ureter. The terminus of the ureter with the turned up cuffs is left protruding (Fig. 4). After suturing of the flaps, which must be neither too tight nor too loose, the mucosa is opened by cautery and the end of the ureter pushed into the lumen of the colon. One additional suture closes the peritoneal flaps over the buried ureter.

The ureter must not be denuded of the periureteral tissue. For fixing the ureters the sutures must pass through the peritoneal flaps and the outer layer of the ureter and periure-

teral tissue, but not through the lumen of the ureter.

It is important that the ureters not be pulled upon by the weight of the colon into which they are implanted. Therefore, the segment of colon into which the implantation is made is fixed to the posterior abdominal wall at the sites of the exit of the ureters from the posterior parietal peritoneum. This fixing (sigmoidopexy) is best done by making use of the appendices epiploicae. By this same sigmodopexy the sites of the implantations become extraperitoneal. This is thought to be one of the most important steps in the operation (Fig. 5).

The abdominal wall is closed without drainage. Following the operation a rectal tube is introduced into the rectum and kept there. The patient is given about 3 liters of 5 per cent glucose in saline intravenously each day. This increases the urinary output and puts pressure into the renal pelvis and ureters and thus diminishes the risk of obstruction to the urinary outflow.

During the first few days after operation these patients develop an acute irritation of the rectum, but this passes away after 2 weeks. Their fluid intake and urinary output must be measured daily. For the first 3 or 4 weeks the patient passes urine every 3 or 4 hours during the day and once every 5 or 6 hours during the night. It is interesting to note that after several months the feces and the urine do not mix and the patient knows when she is going to pass urine and when she is going to have a bowel movement.

One of the patients with tuberculous cystitis had a double ureter on the left side and a single ureter on the right side. The 3 ureters were transplanted at one operation. The 2 ureters on the left side were transplanted into the same opening, the 2 ureters being approximated by sutures of plain catgut going through the perirureteral tissues only.

PROGNOSIS

Sixty-six patients who were subjected to this operation were reported from Mayo Clinic in 1926. Forty-eight of these were living and 18 were dead at time of report. Twenty-nine of the living patients reported upon their condition and of this number 25 were satisfied with the results; 2 had poor control of urine by rectum; 1 was incontinent; and 1 complained of chronic irritation of rectum with diarrhea. In the Mayo series the deaths were classified in two groups; those patients dying in the hospital and those dying after leaving the clinic. Of the former, 5 succumbed to peritonitis and 6 to pyelitis, pyelonephritis, and pyelonephrosis. Seven patients died after leaving the clinic, all from some disease not related to urinary tract.

Transplantation of ureters into the rectosigmoid has been done 19 times at the American University Hospital since 1937. The technique which has been described was used in all cases. The indications for operation were as follows: (1) exstrophy of the bladder, 7 cases; (2) vesicovaginal fistula, 6 cases; (3) tuberculosis of the bladder, 3 cases; (4) trauma to perineum and bladder, 3 cases.

The surgical mortality in this series was 13 per cent. The 2 deaths are reported in some detail below. The other 15 patients have been discharged from the hospital completely continent. The time elapsing between operation and present report varies from 9 years to 1 year. Only 1 patient in this group has been readmitted to the hospital for a urinary complaint. This was a patient with exstrophy of bladder operated upon in 1942, who was admitted 6 months after operation with acute pyelitis. This responded promptly to sulfathiazole therapy and patient left hospital within a few days. One patient complained of persistent diarrhea for several months after leaving hospital. This has subsequently disappeared. Without exception these patients began to gain weight and their general health improved soon after operation. The average patient must discharge the urine from the rectum about every 5 hours during the night and every 3 or 4 hours during the day.

DEATHS FROM TRANSPLANTATION OF URETERS

CASE 39325. In a male baby, 25 days old the diagnosis was exstrophy of the bladder. On April 22, 1942, transplantation of both ureters was done at one operation. The baby died 30 hours after operation, the cause, anuria.

CASE 38842. In a woman, 35 years old, the diagnosis was tuberculous cystitis. Patient had 13 preg-

nancies of which 4 were abortions, 9 normal deliveries. Five of the children died in childhood: 4 are living and healthy. She had cystitis of 3½ years' duration, and had been treated conservatively with irrigations and urinary antiseptics. She had never improved and for the last 2 years had had constant dribbling of urine day and night with burning. Her bladder capacity was 5 cubic centimeters: guinea pig inoculation was positive for Koch's bacillus. Transplantation of both ureters was done on May 29, 1944. Ten days later the wound opened completely and the intestines were eviscerated. These were put back and the wound sutured. The patient developed peritonitis and died 18 days after transplantation of ureters, 8 days after evisceration. There was an average of 1,000 cubic centimeters of urine daily from the rectum.

SUMMARY AND CONCLUSIONS

A simplified technique for ureterosigmoidal transplantation has been described. The important innovations are: (1) elimination of ureteral catheters; (2) single stage operation; (3) transplantation of the left ureter only after bringing it through the mesosigmoid, thus eliminating kinking; (4) eversion of the ureteral ends in order to prevent stricture; (5) fixation of sigmoid to the posterior parietal peritoneum in such a manner as to extraperitonealize the sites of anastomosis.

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THE OBJECT, THE VALUE, AND THE TECHNIQUE OF PREOPERATIVE AND POSTOPERATIVE X-RAY TREATMENT IN CARCINOMA OF THE BREAST

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IN the United States, cancer of the breast caused 16,379 deaths during the year 1944, or a crude death rate from this disease of 12.4 per 100,000. Since the average length of life before death is from 3½ to 4 years, and since about 20 per cent of all cases are cured, we have a right to assume that there are in the United States at present about 60,000 cases of cancer of the breast. In a previous study we have found suggestive evidence that roentgen therapy is of value in the prevention of cancer of the breast, by treating the chronic mastitis which often precedes, and which is commonly associated with, cancer of the breast.

In this paper we shall try to present the value of preoperative and postoperative roentgen therapy. We shall omit discussion of the value of irradiation as a *primary* and single form of treatment of recurrences, the value of which is recognized by nearly everyone. We are further confining this discussion to the stage 2 with axillary metastasis, proved by operation. Harrington, Greenough and Taylor, Lund, and Roeden have shown that microscopic examination is essential for accurate diagnosis of cancer in the axilla.

Roeden discusses the prognostic importance of "sinous catarrh" in the axillary glands, and says, "If the sinous catarrh is of any significance, it must be conceived as an expression of a *preliminary stage to the metastasis* resulting from a toxic irritation, or possibly from an irritation caused by solitary tumor cells."

It would seem to us that with this thought there is an indication for preoperative irradiation whenever there are palpable lymph nodes and perhaps when there are no palpable nodes since there is a possible error of about 30 per cent in such cases. Roeden found that 36 per cent of his 44 patients with sinous catarrh died of cancer, while only 20 per cent of 70 patients who were without sinous catarrh died of cancer.

We believe that patients with operable cancer of the breast should be operated upon, and as promptly as possible. On the other hand, when a patient absolutely refuses operation and refuses to see a surgeon, or for some reason cannot be operated upon, we should give the patient with technically operable cancer the second best chance with primary irradiation. Sometimes after this preliminary irradiation, one can still induce the patient to accept operation, otherwise one must administer the radiation to the limit of the normal tissue toleration.

In using the term "preoperative irradiation," we definitely plan for operation when possible, within 3 or 4 weeks from the beginning of the roentgen therapy, and as soon after the preoperative irradiation as conditions will permit. We do not refer to preoperative roentgen therapy as *just any kind of x-ray therapy* that is given before an operation, but we refer to the treatment given preparatory to and with operation definitely planned. We advise consultation with the family physician, the surgeon, and the radiologist at the beginning, whenever cancer of the breast is suspected, so that the plan of management may be outlined and controlled.

The "operability" of cancer of the breast should not depend merely upon the consent of the patient. Portmann as a radiologist and Haagensen as a surgeon have repeatedly demonstrated that many patients with advanced cancer of the breast would be expected to live longer and be more comfortable without operation. Portmann very properly says, "All patients with cancer of the breast may be oper-

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ated upon, and therefore would be operable. Therefore, these terms operable and inoperable should be discarded and '*surgically curable*' and '*surgically incurable*' should be substituted which would define the objective and limitation of surgical procedures."

The conditions of "operability" (surgically curable) and "inoperability" (surgically incurable) as described by Portmann agree practically with those given by Haagensen (surgeon) and Stout (pathologist). After reviewing the results which they have obtained, Haagensen and Stout say:

"From these correlations we have drawn up a rule for judgment of operability in breast carcinomas as follows: Women of all age groups, who are in good enough general condition to run the risk of major surgery, should be treated by radical mastectomy, except as follows:

"1. When the carcinoma is one which developed during pregnancy or lactation.

"2. When extensive edema of the skin over the breast is present.

"3. When satellite nodules are present in the skin over the breast.

"4. When intercostal or parasternal tumor nodules are present.

"5. When there is edema of the arm.

"6. When proved supraclavicular metastases are present.

"7. When the carcinoma is the inflammatory type.

"8. When distant metastases are demonstrated.

"9. When any two or more of the following signs of locally advanced carcinoma are present:

(a) ulceration of the skin; (b) edema of the skin of limited extent (less than one-third of the skin over the breast involved); (c) fixation of the tumor to the chest wall; (d) axillary lymph nodes measuring 2.5 centimeters, or more in transverse diameter, and proved to contain metastases by biopsy; (e) fixation of axillary lymph nodes to the skin or the deep structures of the axilla, and proved to contain metastases by biopsy."

They say further:

"If these criteria had actually been followed in judging operability in the series of 640 radical mastectomies which we have reported, a total of 109 of the patients would not have been operated upon. Yet the number of patients permanently cured would not have been decreased by a single one."

Harrington who has reported on 6,558 cases of cancer of the breast from the Mayo Clinic does not exclude the pregnant lactating breast or those with a few skin nodules near the tumor.

PREOPERATIVE IRRADIATION

An insufficient number of cases of preoperative irradiation have been recorded to justify any final conclusions from statistics. Many authors have the impression that it is of definite value. Hoffmeyer (Copenhagen) found that after 1000 to 4,800 r were used, histologically a diminution of the cancer cell area corresponds approximately to the macroscopic recession of the tumor, but in no case was there complete disappearance of cancer cells. With the technique which we use, it is not our aim or expectation to destroy all cancer cells but only the more malignant cells which are the more sensitive, and which are more likely to give rise to metastases. Peters of the Toronto General Hospital says, "Stage 2 would be markedly improved by the institution of preoperative radiation in preference to, and in some instances combined, with postoperative treatment."

THEORETICAL AND BIOLOGICAL EVIDENCE FAVORING PREOPERATIVE IRRADIATION

Tendency of preoperative irradiation to devitalize or destroy the more malignant types of cells. It is well known that the microscopic grade of malignancy has much to do with the prognosis of carcinoma of the breast after operation. As indicated in statistics prepared by Harrington in 1935 at the Mayo Clinic, approximately 91 per cent of the group of 1907 patients having invasion of the lymph nodes had *cancer of microscopic grades 3 or 4*, and of the 481 patients having these *grades 3 and 4* who were traced, only 20.5 per cent who had operation alone lived 5 years. Harrington found in a study of 2,396 operable cases at the Mayo Clinic, 80.6 per cent were in *stage 2*. It will be further observed from his table that the patients with cancer of *microscopic grades 3 and 4* represented 90 per cent of the 1,907 patients with involvement of the lymph nodes and those with grades 1 and 2 approximately 10 per cent. It must be clear, therefore, that the greatest problem arises when dealing with *the microscopically more malignant grades 3 and 4*, with axillary involvement or in the *clinical stage 2*. This type represents approximately 80 per cent of all operable cancer of the breast. These microscopic grades of malignancy can be deter-

mined only after a complete operation and a study of the entire breast (Dawson and Tod). Even grades 1 and 2 (representing 10 per cent of all cases) are liable to contain some of the more malignant cells. Therefore, when axillary involvement or enlarged lymph nodes are present, all patients should have both preoperative and postoperative irradiation. Dawson in a study of 460 mammary cancers of all stages of growth found the axillary tissue involved in 70 per cent. Lynham estimated that 75 to 95 per cent of all mammary cancers show spread beyond the actual breast when first examined.

It happens that, so far as the microscopic classification is concerned, grades 3 and 4 are especially radiosensitive while grades 1 and 2 are much less so. This, too, is a matter of common knowledge and common agreement. Unfortunately, grades 3 and 4 lead to early and extensive metastasis and therefore give most of our failures. This is evident in the table mentioned, which shows that in 91 per cent of the total cases of involvement of the lymph nodes the cancer was of grades 3 or 4. It is also self-evident that unless the irradiation is applied to the area in which the malignant cells are located, ultimate failure will result. Therefore, the earlier the diagnosis is made before distant metastasis occurs and the earlier the patient is treated by irradiation, the better will be the end-result. Bloodgood recommended immediate irradiation of the axilla and the breast in all cases of doubtful or malignant tumor.

Because the more malignant type of cells (stages 3 and 4) are rendered less malignant by even a moderate amount of irradiation, it is fair to assume that such irradiation given to a patient with carcinoma of the breast will partially devitalize the more malignant type of cells, which are the cause of extensions and of the surgeon's failures (Halley and Melnick). Because of devitalization of the cancer cells, preoperative irradiation should decrease the recurrences which are due to implantation during operation (Brandes, 1946) and should also render less liable distant metastases which are caused by emboli that have been carried through either the lymph stream or the blood stream, such as may result from the manipulations connected with the operative procedures. Such devitalizing effect of irradiation on the more malignant cancer cells surely occurs immediately, even though it cannot be demonstrated at once microscopically. Therefore, there is no advantage from this standpoint in prolonging the interval before operation, and the operation can take place as soon as the proper amount of irradiation has been given to the tumor areas which we estimate to be about 1200 roentgens, given within a period of 2 weeks.

Normal tissues less receptive to implantation after preoperative irradiation. Biologic experiments (Murphy) and (Russ and Scott) indicate that in addition to the effect of irradiation on the malignant cells there is an effect on normal tissue which is detrimental to implantation of carcinoma. Russ and Scott utilized rats and have exposed to irradiation two of the opposing quadrants of the outer two-thirds of a circle of skin, protecting the central area of the circle and the other two quadrants. They then implanted malignant disease in the unexposed center. In all instances the tumor tissue grew by preference into the unirradiated areas. This effect was evident even when as little as 50 or as much as 100 per cent of an erythema dose was used and was also effectual even when the irradiation was given several days before the inoculation.

In view of these facts, preoperative irradiation is definitely indicated especially when carcinoma of the breast is in clinical stage 2. The preoperative treatment which we recommend can usually be given in approximately 2 weeks, and the patient can be operated on usually during the third week. There is therefore no great delay in the operation, and such irradiation will not interfere with the technical procedures of the operation itself. Preoperative treatment has been recommended by one of us (Pfahler) since 1915, but until recent years relatively few patients have been referred for such treatment, and not enough patients have been given the short type of preoperative treatment to make of value any statistical statement regarding them.

In the past, preoperative treatment has been given to three types of patients: (1) those with cancer in clinical stage 2, previously described;

(2) those with cancer belonging to Steinthal group II-C, which is doubtfully operable but which is made more operable by preoperative treatment; and (3) those with cancer which is totally inoperable but which by prolonged treatment and an interval of 2 or more months is sometimes made operable. For the sake of brevity, we will confine this discussion to cancer which has invaded the axillary nodes but which is still clearly operable, and which we classify as *stage 2*.

Time for operation after preoperative irradiation. As indicated by the investigations of Halley and Melnick, one must not wait too long or regrowth of surviving tumor cells will occur within 4 to 6 weeks. We are recommending operation in about 3 weeks after beginning irradiation or a few days to a week after finishing the preoperative irradiation, or as soon as circumstances permit.

It has been our experience that usually the more advanced cases are referred for preoperative or postoperative x-ray treatment and the more favorable cases in stage 2 are not referred. Adair has studied the results of 7,419 cases of breast cancer, of which 47.6 per cent or 3,535 cases were operable. He states, ". . . the 194 cases treated by surgery alone— represents a 'selected group' as evidenced by the high percentage of 5 year salvage, namely 43 per cent, and the older age level. . . . When no axillary nodes were involved 74.2 per cent 5 year salvage was obtained."

Adair did a masterful piece of research on preoperative irradiation and thought he had solved the problem. He concluded that preoperative irradiation gave no advantage, but he waited from 6 weeks to 3 months after the irradiation for the operation. In 1936, Adair stated that this interval varied from 12 days to 300 days with an average of 66 days. In 1936, referring to the results of radical operation in the hands of the best surgeons, Adair said, "If both the breast and axilla are involved, the 5 year cures are approximately 20 per cent." Adair (1943) found, "Of the 337 patients having axillary involvement, operation and preoperative x-ray treatment, 119 or 35.3 per cent had a 'five year survival'; while "of the 177 patients having axillary involvement subjected to operation immediately and followed by postoperative x-ray treatment, 74-41.8 per cent—survived 5 years."

In waiting so long after the preoperative x-ray treatment Adair was undoubtedly influenced by the opinion of our late great tumor pathologist, Dr. James Ewing. Dr. Ewing had found that more and more cell degeneration developed as time went on, but we think this delay permitted the more resistant types of cancer cell to recover as demonstrated by Halley and Melnick. The delayed operation did permit a better estimate of the value of the primary treatment of cancer of the breast by irradiation. On the other hand, it had the disadvantages of delay in operation, which permits growth of the radioresistant cells and extension beyond the operative or irradiated field.

Halley and Melnick have made an extensive histological study of the effects of irradiation in 300 transplantable rat tumors and also human breasts, and conclude that irradiation by fractional methods acts directly on human breast tumor cells in a two-fold manner, producing early a simple radionecrosis of sensitive cells and later accumulation of mutation-like effects through succeeding generation of daughter cells. Regrowth of surviving tumor cells appears 4 to 6 weeks after termination of therapy. They, therefore, recommend operation within 2 to 4 weeks after a short period of preoperative irradiation.

Stewart believes that preoperative irradiation is bound to raise the number of cures more than is any other method, especially in those cases in which the axillary lymph nodes are involved.

Peterson, Todd, and Russell have reviewed 601 cases treated during 1924 to 1936, some of which received preoperative treatment. They believe from observation in these cases and from results published by others that preoperative is preferable to postoperative roentgen treatment. They state, "It is now fairly generally accepted that a course of postoperative irradiation is a useful prophylactic against local recurrences."

Roeden found that the preoperative treatment yields better results than the postoperative roentgen treatment. He found in stage 1, 71 per cent (38 cases) 5 year survival with op-

eration and postoperative roentgen therapy, and 90 per cent of 48 patients receiving preoperative irradiation, operation, and postoperative roentgen therapy. In stage 2 operation gave only 25.5 per cent of 51 cases; operation plus postoperative roentgen therapy gave 25.5 per cent ("only the more advanced cases received postoperative treatment") and with preoperative roentgen therapy, operation, and postoperative roentgen therapy, there was 36.5 per cent survival. He says, "Practically all cases have been given preoperative irradiation since 1928."

Time for postoperative irradiation. A review of our own records as well as a study of the literature shows that many patients are sent for "postoperative" treatment at a time when they actually have evidence of recurrent disease and should not be class with "postoperative irradiation," but should be grouped with "recurrent carcinoma." It is our opinion that to get the best value from postoperative treatment, the patient should be referred as soon after the operation as her general condition and circumstances will permit, which is usually within 10 days to 2 weeks, even though the wound is not entirely healed. We have not found that postoperative irradiation interferes with the healing of the wound, nor have we found that the wound breaks down because of postoperative irradiation. If preoperative irradiation has been given one may wait 3 or 4 weeks after the operation before giving the postoperative treatment.

Ovarian sterilization as a preoperative or a postoperative prophylactic measure. It is well known that cancer of the breast is more malignant in young women (Sistrunk and MacCarty). Dresser found that of "forty-eight women under 40 treated by radical mastectomy, only 12.5 per cent were free from disease at the end of 3 years." Lee says, "Of the patients 40 years or under, 27 per cent were alive and well at the end of 5 years, whereas of those over 40 years of age, 45 per cent were alive and well at the end of 5 years."

Cancer of the breast also grows more rapidly during pregnancy (Steel). Haagensen gives pregnancy as a contraindication for operation. Therefore, pregnancy should be avoided in a case of cancer of the breast by arresting the ovarian function. Experimental evidence indicates that the ovarian hormones stimulate the production of cancer of the breast in animals of a cancer strain or which have any susceptibility to the development of cancer (Loeb, Lacassagne). In cases of recurrence of metastasis, oophorectomy (Schinzinger, Beatson, Lett, Boyd, Torek, Thomson, and Fouveau de Courmelles) and also ovarian sterilization by irradiation (Dresser, Hoffman) have been followed in a considerable number of cases by a disappearance of the lesions. A woman who has had carcinoma of the breast is proved to be susceptible to the disease and Harrington's (January, 1946) statistics indicate that approximately 70 per cent of 3,511 traced patients with axillary metastases have remnants of the disease in the system after operation, or they would not have died of the disease within 5 years. Consequently, any stimulation from the ovaries in such cases is liable to shorten life. Therefore, we recommend ovarian sterilization for all women with cancer of the breast who are still in the menstrual time of life. Reports by Torek and statistics by Ahlbom seem to indicate some value of ovarian treatment even after the menopause. Dresser, on the other hand, has not been able to recognize any benefit after the menopause.

TECHNIQUE

The technique has varied tremendously not only among different radiologists but even in our own experience. This is natural, for radiotherapy has been a rapidly developing procedure. New knowledge has accumulated since the discovery of roentgen rays approximately 50 years ago concerning both the disease and the effects of irradiation. Therapeutic technique with these rays has been developed or undergone evolution particularly during the past 38 years, beginning with a few scattered workers and gradually spreading until now it is not only universally utilized but is being used in all branches of medicine. Our own experience (Pfahler) in treating carcinoma of the breast covers over 44 years, and naturally there has been a considerable variation in technique during this evolution. No technique can be standardized even yet. Considering general principles, our own technique has in-

volved from the beginning to the present time the use of fractional dosage carried over a considerable period. Therefore, instead of reviewing all that has been done and the variations that have taken place, we will be content with a description of our own present technique, which may be modified as newer knowledge is developed.

Technique for short preoperative treatment. Short preoperative treatment is used when the cancer is still clearly in an operable stage but is no longer confined to the breast. The object is to devitalize the more malignant type of cells with moderate dosage without causing undue delay or interference with the operation itself and with no expectation of destroying all cancer cells in the treated area. Of course no effect is produced on the cancer outside of the area treated. Ordinarily we aim to finish this preoperative treatment in approximately 2 weeks and to give approximately 1000 to 1400 roentgens through each side of the breast and through the axillary and supraclavicular region, and when there is much fat or advanced axillary glandular enlargement an additional posterior axillary portal is used. This is approximately the same dosage in each portal as is used in the preoperative treatment in Stockholm — Radiumhemmet and Maria Hospital (Berven and Roeden)—Sophiahemmet (Forssell)—Red Cross Hospital (Åkerlund), but we use four or five portals instead of two because we believe that it gives better distribution even though it involves more work. The crossfire value of this will equal approximately 200 to 350 r units in the diseased area at each treatment or a total of 1000 to 1400 roentgens in the tumor area. For all of this treatment, we utilize 180 or 200 kilovolts, 50 cubic centimeter distance, and 0.5 millimeter of copper filtration. For portals (Fig. 1) we utilize the space from the parasternal line to the nipple line, turning the patient on the side and irradiating tangentially, so that the rays will include the chest wall but not penetrate the lungs. A similar tangential dose is given through the mammary area externally, extending from the midaxillary line to the nipple line, also tangentially, avoiding penetration of the lung but including the chest wall. An axillary portal occupies the space between the posterior and the anterior axillary folds, and the rays are directed upward and inward so as to irradiate the axilla, the coracoid or infraclavicular region and the deeper portion of the supraclavicular area; tangential rays are again utilized and the chest walls and the upper mediastinum included but not the lung. A portal is then utilized including the supraclavicular region and the coracoid region and the rays carried from the lower border of the anterior axillary fold upward and inward to the lower border of the sternoclavicular junction; in stouter persons, a similar portal is utilized through the posterior axillary field, the same general principles being carried out. This should give a rather even distribution of irradiation and should give approximately an erythema dose value into all of these tissues. This amount of irradiation is intended to be supplemented by postoperative irradiation. We are very particular about the exact division of portals, and the exact direction and the distribution of the rays so as to secure a uniform irradiation and to miss none of the corners.

Technique of postoperative irradiation (Fig. 2). We generally begin postoperative treatment through a portal occupying the supraclavicular and coracoid region, outlined approximately similar to the one utilized in the preoperative treatment, and for a second portal of entry we usually use the posterior axilla, with the arm thrown over to the opposite shoulder and the rays directed into the axilla, into the deeper part of the supraclavicular region and toward the upper part of the mediastinum. Generally the arm cannot be abducted sufficiently to get a portal of entry into the axilla itself after operation. As a third portal we utilize a large area extending from the lower border of the coracoid and supraclavicular portal to the level of the epigastrium and extending from the right border of the sternum to the left anterior axillary fold. Because of the large area involved, because of the lung and the heart underneath and because irradiation of this area is apt to give rise to radiation sickness, we give relatively smaller doses over this field. We utilize for postoperative treatment over this portal the so called low voltage technique, using 135 kilovolts, 2

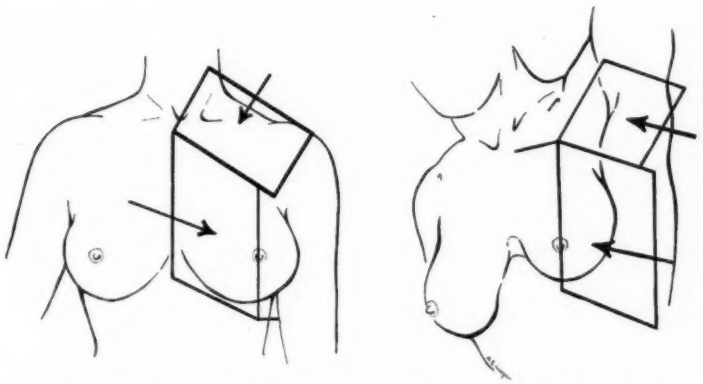

Fig. 1. Shows the areas utilized for preoperative treatment. These areas are carefully marked on the skin so that no part of the skin is doubly treated or is missed. The supraclavicular area is directed to the lymphatic area extending from the axilla to the upper mediastinum. In order to bring the axillary tissue into the field, a small sandbag placed in the posterior axillary depression and with the arm separated from the body will permit more radiation to reach the deeper part of the axilla. For the inner field of the breast, the patient is rotated on the affected side with the sandbag placed under the breast so as to bring the breast almost on a level with the treatment localizer. For the external portal, the patient is rotated to the opposite side. The breast is propped up with a sandbag so as to bring not only the entire breast but part of the tissue outside of the breast into the field for treatment. For the axillary field, the arm is placed above the head and the rays are directed into the axilla and toward the base of the neck and upper mediastinum.

millimeters of aluminum filtration and 50 centimeter distance. Generally we can give only about 200 or 300 roentgens in each application, sometimes less, but we aim to deliver into this area a total of approximately 1,800 to 2,400 roentgens, counting both preoperative and postoperative treatment. The treatment is given according to the "saturation technique," and we should not exceed a full erythema dose at any time. We aim to deliver into the axilla, coracoid, and supraclavicular region approximately 1,800 to 2,400 roentgens.

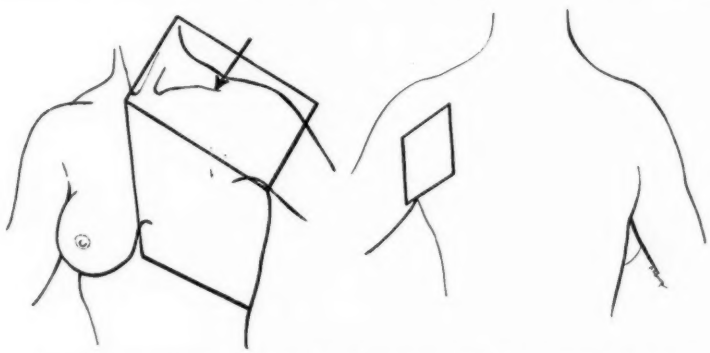

Fig. 2. For postoperative irradiation the supraclavicular area is handled as in Figure 1. The operative field is brought into position by rotating the patient so as to level the area as much as possible. The axillary space is treated postoperatively chiefly through the posterior axilla because one generally cannot raise the arm sufficiently to go directly.

This will bring about a definite erythema, but we have not found that it interferes with the healing of the wound or the convalescence of the patient. If there has been no preoperative irradiation we believe that the postoperative treatment should begin about 2 weeks after operation, while the congestion is present and while any cells that have been implanted or transferred are not yet completely adapted to the tissues of the host, and while the cancer cell is more radiosensitive than it would be later. If preoperative treatment has been given we can wait 3 or 4 weeks to begin postoperative treatment.

To help in the avoidance of radiation sickness we generally give intramuscular injections of 10 milligrams of thiamin chloride, or more recently one of two preparations with the following formulae, in each cubic centimeter of solution:

	milligrams		milligrams
(a) Thiamin hydrochloride	10	(b) Thiamin chloride	30.0
Riboflavin	10	Riboflavin	3.0
Pyridoxine hydrochloride	5	Nicotinamide	70.0
Calcium pantothenate	50	Calcium pantothenate	5.0
Nicotinamide	250	Pyridoxine	5.0

THEORETICAL AND BIOLOGIC CONSIDERATIONS FOR POSTOPERATIVE IRRADIATION

Local postoperative treatment is intended (1) to destroy any malignant cells that may have been transplanted during operation, (2) to destroy any microscopic remnant of cancer tissue which the surgeon may have missed, and (3) to render the normal tissue more resistant to cancerous growth. Definite evidence of implantation is furnished by the rare observation of clearly demonstrable stitch hole recurrences. Other more frequent implantations probably occur under the skin flap. It is our impression that remnants of cancerous tissue left behind are rendered more malignant and also more radiosensitive by the congestion following the traumatism of operation, unless controlled by postoperative irradiation. It is generally admitted that local and regional recurrence is the result of incomplete operation, but since 38 per cent of the patients whose operation is a failure have local recurrences and 15 per cent axillary recurrence (Creyssel and Morel), it is seen that 53 per cent of the operations which fail are incomplete. All of these recommendations are intended to lessen the number of failures connected with surgical intervention, for in the clinics where the basic principles of radiotherapy have been followed most closely and where the radiologists have mastered a good technique, postoperative irradiation has become almost a routine procedure.

Since almost everyone recognizes that roentgen therapy is of value in the treatment of recurrent cancer, and since recurrent cancer is proof that cancer cells were left behind at the time of operation, it is reasonable to assume that the same irradiation given while the disease is only microscopic and the cancer cells not yet well nourished and adapted to their surroundings, will produce even a better chance of destroying the disease. It is unreasonable to expect cure or prevention of cancer that develops at points distant to the area treated.

Haagensen and Stout in their masterful review of 640 cases in all stages obtained 47 per cent of 5 year survivals after operation, but local recurrences occurred in 22.8 per cent. It would seem that thorough postoperative roentgen treatment might prevent many of these since even they favor irradiation for recurrences. Surely recurrences at the beginning are more easily controlled.

Tables I, II, III, IV, and V represent a fair review of the available records in most of the leading clinics throughout the world so far as they can be recognized as to the stage of the disease.

DISCUSSION

Every physician, surgeon or radiologist knows that carcinoma of the breast and its treatment is a very complicated problem. As will be observed in Table I, with surgery alone, referring to stage 2 cases, the 5 year survival percentage varies from 24.3 to 47.3 per cent, and with surgery and postoperative roentgen treatment, the variation is 25.5 to 41.8 per cent. In general, the results show some improvement as a result of postoperative irradiation.

In Table II, there is involved a much larger percentage of cases which were treated by surgery alone in different clinics as compared with

the combination of surgery and postoperative irradiation in another series of clinics. It has not been possible in all instances to separate in the records the cases in stage 2, and because of that fact some excellent records have been omitted. It is self-evident that if the records are made up of stages 1 and 2, or possibly stages 1, 2, and 3, the end-results will vary with the number of stage 1 cases that are added. It will be seen, however, that in spite of these tremendous variations, there is a general improvement when postoperative irradiation has been used.

In the group of stage 2 cases in Table III treated with preoperative and postoperative roentgen therapy, the general results are shown to be still better than with postoperative treatment alone.

Table IV and the associated letter and comments refer to the records made by Dr. Gordon Richards, which he is preparing for presentation in London in the near future.

Table V refers to the review of our own records of postoperative roentgen treatment during the period 1902 to 1941, or approximately 40 years. These results are influenced by the operative results from many different surgeons, and therefore again can be depended upon only as an impression.

The statistical records show a tremendous variation in the terminal results whether pa-

TABLE I.—RECENT COMPARATIVE 5 YEAR RESULTS IN BREAST CANCER, STAGE 2

Author	Surgery alone		Surgery and postoperative irradiation	
	No. cases	Per cent living 5 years	No. cases	Per cent living 5 years
Adair	83	47.3	177[1]	41.8
Graves	46	33.0	35	40.0
Haagensen & Stout	154	24.7	143[4]	31.5
Harrington (1940)	732	24.3	2011[2]	29.4
Roeden	51	25.5	51[3]	25.5

[1]Adair says these cases were "selected."
[2]Harrington (Report 1940). The surgery was done in the Mayo Clinic—one of the greatest clinics in the world, but the postoperative irradiation in most cases was carried out at scattered points throughout the country.
[3]Only the more advanced cases received postoperative treatment in the early records.
Remarks: It is the general opinion of many leading radiologists that in many clinics only the more advanced or unfavorable cases in "stage 2" are referred for postoperative irradiation. [4]Haagensen and Stout say, "In evaluating these data we again meet with the fact that postoperative prophylactic radiation is more often administered to advanced cases, which prejudices the results."

TABLE II.—RECENT COMPARATIVE 5 YEAR RESULTS IN BREAST CANCER IN STAGE 2—OPERATED UPON IN DIFFERENT CLINICS, SHOWING RESULTS WITH SURGERY ALONE AND WITH POSTOPERATIVE IRRADIATION

Surgery alone				Surgery and postoperative irradiation			
Author	Total No. cases all stages	Percentage living 5 years		Author	Total No. cases all stages	Percentage living 5 years	
		Per cent	Cases			Per cent	Cases
Haagensen & Stout	640	21.0	of 385	Evans and Leucutia	175	46.6	of 45
Harrington (1945)	5407	30.4	of 3348	Graves	376	24.0	of 168
Jessop (1936)	216	30.5	of 96	Gylstorff and Peterson	601	27.0	of 354
Simmons (M.G.H.)	147	30.0	of 99	Gratzek and Stenstrom	254	51.0	of 254
Simmons (Huntingdon)	116	25.0	of 74	Pfahler and Keefer	316	44.0	of 193
				Pohle and Benson	42	28.0	of 25
				Richards	110	53.5	of 36
				Westermark	70	37.0	of 55
				Weisswange	236	27.1	of 76
Average		27.4		Average		37.6	

Many of the available records do not indicate the exact number of cases in stage 2 but give only the percentage of "survival" cases in stage 2 and are therefore not used here.
Richards has divided his cases with axillary involvement into 2 stages which when combined show approximately 53.5 per cent survival.
The averages of the percentages reported by these authors show a greater possibility for 5 year survival when surgery is followed by postoperative irradiation, than when surgery is used alone.

Inter-American Congress of Radiologists, Havana, Cuba, November 17–22, 1946.

TABLE III.—PATIENTS SYMPTOM FREE 5 YEARS AFTER TREATMENT WITH SURGERY AND BOTH PREOPERATIVE AND POSTOPERATIVE ROENTGEN IRRADIATION FOR CANCER OF THE BREAST, STAGE 2

Author	No. cases stage 2	Stage 2 percentage survival
Ahlbom, Radiumhemmet 1941	391	24.0
Pfahler and Keefer	65	52.3
Roeden	52	36.5

Remarks: It is very difficult to compare the results from different clinics because of the differences in classification, difference in technique and difference in the objectives. Recently I have had the privilege of visiting Dr. Gordon Richards at the Radiologic Institute of the Toronto General Hospital and have been deeply impressed with his fine results. He is preparing a paper on this subject and at my request has sent the following personal communication:

"I am enclosing herewith a chart Table IV which shows the position in connection with our *preoperative breast cases* as completely as I have been able to analyze the results up to the present. This shows the results of treatment of eighty-two preoperative cases up to and including the year 1940. We have compared these results with one consecutive group of typical conventional *postoperative cases* of approximately the same number, which actually was the group of cases treated postoperatively during the year 1939. It might be said that this is unfair but at least it is a typical group and comparable in size to the preoperative group. *Most of the preoperatives treated were very advanced* and in our own work, instead of the usual classification into three groups or stages, we have broken them down into five groups:

Group 1.—Represents the quite early stage.
Group 2.—Moderately advanced but still operable according to the usual criteria.
Group 3.—More advanced—borderline of inoperability.
Group 4.—Far advanced—agreed by all as inoperable.
Group 5.—Inflammatory types or carcinoma associated with lactation.

"It is interesting to me to note that there is a fairly substantial improvement in all of these groups and that the *only patients in Group 5 who survived five years* were treated radiologically. Some of the preoperative cases came to operation and of those who did so twenty-five per cent were negative for cancer at operation. Since most of these were quite advanced prior to treatment, I think it speaks well for preoperative treatment."

TABLE IV.—PREOPERATIVE COMPARED WITH POSTOPERATIVE ROENTGEN TREATMENT GORDON RICHARDS

Group	Total No. cases C. I. M. Group		Alive or controlled				Gain due to preoperative therapy Per cent
			Preoperative		Postoperative		
	Preoperative	Postoperative	No. of cases	Per cent of total of group	No. of cases	Per cent of total of group	
I		22			20	91	
II	6	20	5	83.3	15	75	8
III	35	50	17	48.6	16	32	16.5
IV	33	16	9	27.3	3	18.7	8.6
V	8	2	1	12.5	0	0	12.5
Total	82	110	32		54		

Remarks: It will be observed that Richards has deliberately compared the value of "preoperative" with "postoperative" irradiation, and finds the preoperative superior. In contradistinction to our technique, he gives the limit of irradiation preoperatively and it is followed after a longer time by operation, somewhat like the work reported by Adair, but it will be seen that Richards has produced very superior and convincing results. The results in the inflammatory types of carcinoma associated with lactation are truly remarkable.

tients are treated by operation alone or treated by a combination of operation and irradiation.

Classification of cases as to clinical stages 1, 2, and 3 is extremely difficult. It depends upon the experience and clinical judgment of the individual physician, or the associated group. We all know that even though we classify those *patients having metastases in the axilla* as proved by surgery as belonging to "stage 2," there is still in this group a considerable variation. The early recognition will depend in part upon the early consultation by the patient, and also upon the skill with which lymph nodes are recognized by the physician, and the results will depend upon the promptness with which the operation is performed on the one hand, and on the other hand, the de-

TABLE V.—SUMMARY OF RESULTS IN BREAST CANCER ALL STAGES 1902–1941. SURGERY PLUS POSTOPERATIVE ROENTGEN THERAPY SYMPTOM FREE 5 OR MORE YEARS (PFAHLER) (REVIEW OF THE RECORDS AND TABLE PREPARED BY DR. GEORGE P. KEEFER).

	Total	1902 – 1922		Total	1922 – 9/1/33			Total	9/1/33 – 5/1/41			1902 to 1941
		Stage 1	Stage 2		Stage 1	Stage 2	Stage 3		Stage 1	Stage 2	Stage 3	
Well 5 years	81	35–66%	46–41%	63	33–73%	28–51%	2–14%	19	8–100%	11–44%		163–51%
Died carcinoma	85	18	67	51	12	27	12	17		14	3	153
Died of intercurrent disease	8			9				2	1	1		
Not traced	19			5				2				
Total all cases	193			128				40				316

44 per cent of 193 cases in stage 2 treated during 39 years were well 5 years.
51.5 per cent of 316 cases in all stages well 5 years or more.
261 cases of primary carcinoma of the breast treated only by irradiation are not included in above series.
521 cases of recurrent carcinoma of the breast following operation and treatment begun more than 2 months after operation and in which there was definite recurrence when first seen by us, are not included in the above analysis.

lay and the more advanced stage in the later cases. Therefore, one surgeon may have a more advanced group than another. This will, of course, affect the final results both when treated by operation alone, and also when treated with operation and irradiation.

In like manner, there is a variation to the thoroughness with which various surgeons do the "radical" or "Halsted" operation. One competent surgeon may do his operation in 1 hour, and another competent surgeon may take 4 hours. Haagensen and Stout's records show that following operations taking 1 hour or less, 28.6 per cent of 56 cases survived 5 years and developed 23.2 per cent local recurrences, while of 16 cases taking 4 hours or more gave 56.3 per cent 5 year survivals, and only 12.5 per cent local recurrences. Presumably, therefore, the long operations are more thorough.

The effects of the preoperative irradiation will depend in part upon the thoroughness and the skill with which each dose is applied, and will also be influenced by the relative time of the operation in relation to this preliminary treatment, and will be affected in like manner by the skill, amount of irradiation, and time of its application for postoperative roentgen treatment.

The results in the treatment of carcinoma of the breast cannot at present be reduced to mathematical accuracy. Therefore, we are still dependent upon the general impression which in our opinion is favorable to both preoperative and postoperative irradiation, but it should be applicable particularly to those cases of carcinoma of the breast, associated with palpable lymph nodes; in this group it has been proven that there is a possible error of nearly 30 per cent.

CONCLUSIONS

1. Good results in the treatment of carcinoma of the breast depend primarily upon *early* recognition, accurate diagnosis, and thorough operation.

2. The operative results can be improved by preoperative and postoperative roentgen therapy, or by a combination of all three.

3. The good results will depend upon the knowledge, the skill, and the thoroughness with which each of these therapeutic measures is applied.

4. A review of the results obtained in leading clinics throughout the world confirms the above conclusions.

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THE CYSTIC ARTERY AND CONSTITUENTS OF THE HEPATIC PEDICLE

A Study of 500 Specimens

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IN the colic and jejunoileal portions of the digestive tube, arterial variation is of a relatively simple order being of the sort encountered in the origin of branches from the trunk of a tree and of twigs from the branches. Simplicity is an adult characteristic of the pattern because developmental change in the small intestine is chiefly one of elongation.

In the arterial supply of the gastroduodenal part of the tube, on the contrary, variations are striking, since the simple arboriform scheme is profoundly altered by growth of the liver and pancreas, by the assumption of a curved form by the stomach and duodenum, and by the development of the spleen in the dorsal mesogastrium. These factors operate to complicate the plan of branching of the celiac axis and of the proximal segment of the superior mesenteric artery. Comparably, the liver, in being derived from a portion of the primitive gut supplied primordially by the celiac and mesenteric arteries, may receive rami from both of these sources. The same is true of the gall bladder, since the latter is situated in the portal area upon which the several hepatic vessels converge.

Contribution No. 439 from the Anatomical Laboratory of Northwestern University Medical School. Paper to be presented, in brief, before the Forum on Fundamental Surgical Problems at the September (1947) meeting of the Clinical Congress of the American College of Surgeons.

The comments on surgical application are based mainly upon the observations of Dr. Daseler, made during the period of his fellowship at the University Hospital, Ann Arbor, Michigan, and currently as trainee of the National Cancer Institute in surgery at the University of Michigan. The authors are indebted to Dr. F. A. Coller, Chief of the Department of Surgery, University of Michigan, for critical reading of the manuscript. The anatomical investigation, which extended through a period of several years, is based chiefly upon examination of specimens in the Anatomical Laboratory of Northwestern University Medical School; the data were augmented through study of specimens at Northwestern University Dental School, at the College of Medicine of the University of Illinois, and at Chicago Medical School, through the courtesy of Doctors K. L. Vehe and M. M. Kamins, O. F. Kampmeier, and J. J. Sheinin. (B.J.A.)

In the arterial supply of the adult liver and the gall bladder, certain patterns are preponderant, others infrequent. A presentation of the types, with record of their frequency, should be of interest to the surgeon and to the anatomist.

Materials and Methods

In the course of the present investigations 500 laboratory specimens were studied consecutively. A sketch was made of each set of vessels. On the basis of these permanent records, types of vascular arrangement were selected. Then for each major type, a specimen was selected for illustration. In addition to the types actually encountered, several described by other investigators (but not found in the current series) have been figured. These are shown in diagrammatic form (Figs. 1 to 79). In order to record relationships, course, and caliber of the arteries in this area, 14 specimens were employed for more accurate portrayal of anatomic features.[1]

For the convenience of the reader, the statistical results of the study have been tabulated (Table I).

Observations and Discussion

A. Arteries

Common hepatic artery. The common hepatic artery arose as a branch of the celiac axis (Fig. 1) in 83.20 per cent of cases (416 of 500). It was absent (Fig. 84) in 12.20 per cent (61 cases). In cases of absence of the common hepatic, the right and left hepatic lobes were supplied by separate arterial branches.

[1]In Figures 80 through 93 the liver has been elevated to expose the inferior surface; peritoneal structures have been removed, but the constituents of the hepatic pedicle restored to approximately normal interrelationship. In Figure 86 the gall bladder has been lifted out of the fossa to the left, in Figures 87 and 93 to the right. In Figure 93 a portion of the left lobe has been cut away and the transected superior mesenteric artery has been similarly retracted.

TABLE I.—OBSERVATIONS ON ORIGIN AND POSITION OF ARTERIES IN OR NEAR HEPATIC PEDICLE

1. Origin, etc., of common hepatic (or hepatic) artery; 500 cases:
   - celiac, 416
   - superior mesenteric, 22
   - aorta, 1
   - absent, 61
2. Origin of right hepatic artery (right ramus of hepatic proper): 500 cases:
   - common hepatic, 416
   - superior mesenteric, 56
   - replacing common hepatic, 23
   - celiac, 4
   - aorta, 1
3. Origin of accessory right hepatic artery; 36 cases:
   - superior mesenteric, 15
   - left hepatic, 13
   - gastroduodenal, 5
   - celiac, 2
   - aorta, 1
4. Origin of left hepatic artery; 500 cases:
   - common hepatic, 410
   - celiac, 57
   - replacing common hepatic, 23
   - left gastric, 9
   - gastroduodenal, 1
5. Origin of accessory left hepatic artery: 175 cases:
   - right hepatic, 99
   - left gastric, 54
   - common hepatic, 11
   - gastroduodenal, 6
   - celiac, 5
6. Origin of gastroduodenal artery: 500 cases:
   - common hepatic, 377
   - replacing left hepatic, 52
   - right hepatic, 35
   - replacing common hepatic, 19
   - accessory left hepatic, 2
   - celiac, 1
   - absent, 14
7. Origin of right gastric artery; 250 cases:
   - common hepatic, 125
   - left hepatic, 81
   - gastroduodenal, 33
   - right hepatic, 10
   - celiac, 1
8. Origin of cystic artery; 580 cases:
   - right division of regular hepatic, 416
   - right hepatic from superior mesenteric, 90
   - left hepatic, 36
   - common hepatic, 16
   - gastroduodenal, 15
   - replacing or accessory right hepatic, 3
   - celiac, 2
   - superior mesenteric, 1
   - superior pancreaticoduodenal, 1
9. Origin of accessory cystic artery; 65 cases:
   - right hepatic, 50
   - gastroduodenal, 6
   - common hepatic, 4
   - left hepatic, 3
   - accessory right hepatic from superior mesenteric, 2
10. Origin of single replacing cystic artery; 120 cases:
   - replacing right hepatic from superior mesenteric, 36
   - left hepatic, 27
   - right hepatic from replacing common hepatic, 21
   - accessory right hepatic from superior mesenteric, 12
   - common hepatic, 11
   - gastroduodenal, 6
   - accessory right hepatic from celiac, 3
   - celiac, 2
   - superior mesenteric, 1
   - superior pancreaticoduodenal, 1
11. Origin of dual replacing cystic arteries; 15 cases:
   - both from right hepatic branch of superior mesenteric, 7
   - replacing right hepatic and left hepatic, 3
   - both from left hepatic, 1
   - gastroduodenal and accessory right hepatic, 1
   - gastroduodenal and right hepatic branch from celiac, 1
   - gastroduodenal and left hepatic, 1
   - gastroduodenal and right hepatic branch of superior mesenteric, 1
12. Location of hepatic (common hepatic) artery; 439 cases:
   - left of common bile duct, 431
   - posterior to same, 7
   - anterior to same, 1
13. Location of right hepatic artery; 500 cases:
   - posterior to common hepatic duct, 325
   - anterior to common hepatic duct, 58
   - posterior to common bile duct, 58
   - right of duct system, 22
   - posterior to right and left hepatic ducts, 18
   - left of duct system, 8
   - anterior to common bile duct, 7
   - anterior to right and left hepatic ducts, 4
14. Location of cystic artery; 580 vessels:
   - Chalot's triangle, 405
   - anterior to common hepatic duct, 123
   - anterior to common bile duct, 17
   - posterior to common hepatic duct, 12
   - between hepatic ducts, 6
   - anterior to cystic duct and right hepatic duct, 6
   - right of duct system, 5
   - posterior to common bile duct, 3
   - left of duct system, 2
   - posterior to cystic duct and right hepatic duct, 1

A replacing type of common hepatic artery was present (Fig. 93) in 4.6 per cent of specimens (23 cases). In almost all instances (22 of 23) the replacing vessel was derived from the superior mesenteric artery (1 from aorta).

In 81.54 per cent of the cases (358 of 439 studied) the common hepatic artery was a long trunk, which did not break up into its hepatic branches until it had come within 4 centimeters of reaching the liver surface (Fig. 88); in 18.46 per cent (81 cases) the artery was short, and divided into hepatic branches that ascended as separate trunks for a distance of more than 4 centimeters (Fig. 87).

Regarding relation to the biliary duct system, it may be said that in 98.1 per cent of the

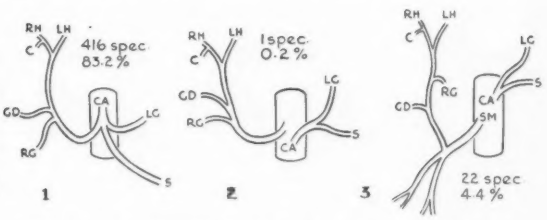
specimens (431 of the 439) the common hepatic artery coursed entirely to the left of the common bile duct (Fig. 88). In only 1.6 per cent (7 cases) the artery crossed posterior to the common bile duct; in 0.2 per cent (1 case) it crossed the common duct anteriorly; in 0.4 per cent (2 cases) it crossed posterior to the cystic duct before dividing into its terminal right and left hepatic branches.

Right hepatic artery. A normal right hepatic artery (i.e., one which supplies the right lobe of the liver, after origin from a normal common hepatic artery as in Fig. 80) was present in 83.2 per cent of the cases (416 of 500).

A replacing type of right hepatic artery (*i.e.*, one by which the right lobe is supplied from other than the above-mentioned source) was present in 16.8 per cent (84 cases). In 11.2 per cent (56 cases) the vessel supplying the right hepatic lobe originated from the superior mesenteric artery (Fig. 5), while in 1 case (Fig. 9) it arose from the aorta. In 4.4 per cent (22 cases) the right hepatic lobe was supplied by the right hepatic branch of a common hepatic artery derived from the superior mesenteric artery (Fig. 12), while in 0.2 per cent (1 case) the common hepatic artery arose directly from the aorta (Fig. 8). In 0.8 per cent (4 cases) the right hepatic artery arose as a direct branch of the celiac axis (Fig. 13), independent of the left hepatic branch.

Accessory right hepatic arteries supplying the right hepatic lobe, additive to a normal or replacing artery, occurred with an incidence of 7.2 per cent (36 cases). In 3 per cent (15 cases) the accessory right hepatic artery arose as a branch of the superior mesenteric artery (Fig. 6), in 2.6 per cent (13 cases) as a branch of the left hepatic artery (Fig. 15), in 1 per cent (5 cases) from the gastroduodenal artery (Fig. 11), in 0.4 per cent (2 cases) from the celiac axis (Fig. 14) and in only 0.2 per cent (1 case) directly from the aorta (Fig. 10).

The location and course of the right hepatic artery are subject to considerable variation. In 65 per cent (325 cases) the artery crossed from left to right, posterior to the common hepatic duct (Fig. 80); in 3.6 per cent (18 cases) it crossed posterior to the right and left hepatic ducts at a level higher than their juncture. In 11.6 per cent (58 cases) the right hepatic



Figs. 1 to 3. Common hepatic artery (*arteria hepatica*, BNA); variations in origin, shown diagrammatically. Abbreviations (Figs. 1 to 79): *ALH*, accessory left hepatic artery; *ARH*, accessory right hepatic: *C*, cystic; *CA*, celiac (axis); *GD*, gastroduodenal; *LG*, left gastric; *LH*, left hepatic; *RG*, right gastric; *RH*, right hepatic; *RRH*, replacing right hepatic; *S*, splenic; *SM*, superior mesenteric.

artery crossed anterior to the common hepatic duct (Fig. 83), while in only 0.8 per cent (4 cases) it crossed anterior to the right and left hepatic ducts above their point of union. In 11.6 per cent of the specimens (58 cases) the right hepatic artery crossed posterior to the common bile duct (Fig. 84); in 1.4 per cent (7 cases) it crossed the common duct anteriorly (Fig. 87). In 4.4 per cent (22 specimens) the same artery coursed entirely to the right of the common bile duct and hepatic ducts, in 1.6 per cent (8 cases) entirely to the left thereof. In 11.4 per cent (57 cases) the artery crossed posterior to the cystic duct (Fig. 87), while in 0.8 per cent (4 cases) it crossed the cystic duct anteriorly.

Left hepatic artery. A normal left hepatic artery (i.e., one which originates from a normal common hepatic artery and supplies the left lobe of the liver, as in Fig. 89) occurred in 82 per cent of the specimens (410 of 500). In 1.4 per cent (7 cases) the artery crossed anterior to the right hepatic artery, in 0.4 per cent (2 cases) posterior to it.

A replacing type of left hepatic artery occurred in 18 per cent of the specimens (90 of the 500 cases). In 11.4 per cent (57 cases) this artery arose directly from the celiac axis (Figs. 20 and 25), in 1.8 per cent (9 cases) from the left gastric artery (Fig. 23), in 4.4 per cent (22 cases) from a replacing type of common hepatic artery which in turn arose from the superior mesenteric artery (Fig. 22); in 0.2 per cent (1 case) it was a branch of a replacing type of common hepatic artery which in turn arose as a direct branch of the aorta (Fig. 19), and in

0.2 per cent (1 specimen) it was derived from the gastroduodenal (Fig. 26).

An accessory left hepatic artery was encountered with an incidence of 35 per cent (175 in 500 specimens). In 19.8 per cent (99 cases) the vessel originated as a branch of the right hepatic artery (Fig. 18), in 10.8 per cent (54 cases) from the left gastric artery (Fig. 21), in 2.2 per cent (11 cases) from the common hepatic artery (Fig. 29), in 1.0 per cent (5 specimens) directly from the celiac axis (Fig. 27) and in 1.2 per cent (6 cases) as a branch of the gastroduodenal artery (Fig. 30).

Gastroduodenal artery. The gastroduodenal artery arose as is considered "normal," from the common hepatic artery (Fig. 80) with a frequency of 75.4 per cent (377 of 500 cases); in 14.8 per cent (56 of the 377 cases) it came from this source vessel as one of the terminal branches of a short trunk (Fig. 90), and in 85.2 per cent (321 cases) as the first branch of a long common hepatic artery (Fig. 83).

A gastroduodenal artery of replacing type was present in 21.8 per cent of the specimens (109 of 500); in 10.4 per cent (52 of the 109) it arose as a branch of a replacing type of left hepatic artery (Fig. 84), and in 0.4 per cent (2 cases) as a branch of an accessory left hepatic artery derived in turn from the celiac axis (Fig. 44). In 3.6 per cent (18 cases) the gastroduodenal artery was a branch of a replacing type of common hepatic artery derived in turn from the superior mesenteric artery (Fig 93), and in 7.0 per cent (35 cases) it took origin from the right hepatic artery (Figs. 34, 41, and 43). In 0.2 per cent (1 case) it arose as a direct branch of the celiac axis (Fig. 36), and in another 0.2 per cent (1 case) from a replacing common hepatic artery which in turn arose directly from the aorta (Fig. 35).

The gastroduodenal artery was absent in 2.8 per cent of the specimens (14 of the 500), the region usually supplied by the artery being cared for by branches of the hepatic, left gastroepiploic, and inferior pancreaticoduodenal arteries.[1]

The location of the gastroduodenal artery in relation to the common bile duct is of extreme importance to the surgeon and it is unfortunate that accurate figures of such relationships were not obtained in the present study. However, Thompson (1933) and Eisendrath (1920) have found the vessel to be situated entirely to the left of the ductal system in 40 to 50 per cent of their cases and crossing the anterior aspect of the supraduodenal or retroduodenal portions of the duct in 50 to 60 per cent of their cases.

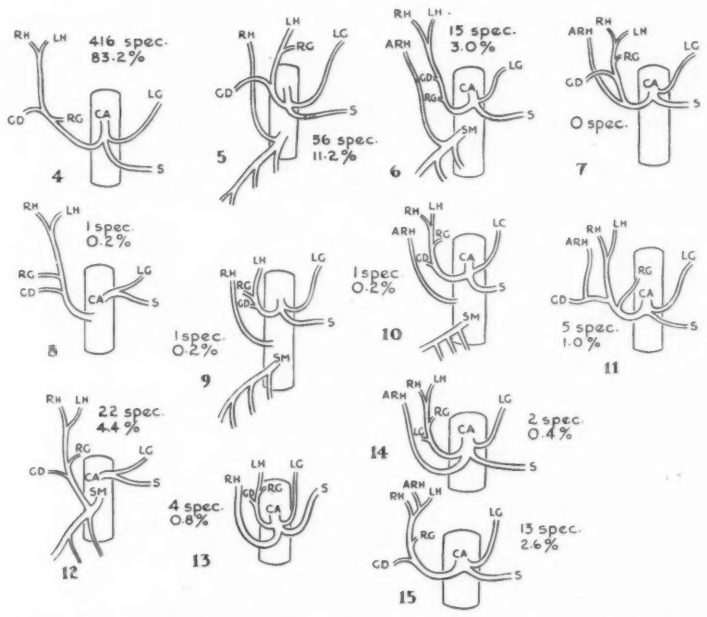
Right gastric artery. When the present study was started, it was not originally intended that the right gastric artery should be included. As a result, this vessel is depicted in but 250 of the records.[2] Browne (1940) reported absence of the vessel in 10 per cent of cases; the present study, for the reason just mentioned, cannot provide corroborative data.

The right gastric artery arose as a branch of the common hepatic artery (Fig. 46) in 50 per cent of the cases (125 of 250). In 4.4 per cent of these cases (11 of 250) the artery arose as a branch of a replacing type of common hepatic artery (Figs. 50 and 54), in 32.4 per cent (81 cases) as a branch of the left hepatic artery (Fig. 47). In 7.6 per cent (19 cases) this left hepatic artery was of a replacing type (Figs. 55 and 64). while in 2.0 per cent (5 cases) the left hepatic source of the right gastric artery took its origin from a common hepatic artery derived in turn from the superior mesenteric artery (Fig. 58). In 4 per cent (10 of 250) the right gastric artery arose as a branch of a normal right hepatic artery (Fig. 48), in 13.2 per cent (33 cases) as a branch of a gastroduodenal artery (Fig. 49), in 2 of these cases (0.8 per cent) the gastroduodenal artery was of a replacing type, taking its origin from a replacing left hepatic artery of celiac origin (Fig. 61). In a single specimen (0.4 per cent) the right gastric arose as a direct branch of the celiac axis (Fig. 65).

Cystic artery. The "normal" cystic artery is regularly described as a branch of the right he-

[1]At the present time, two of the authors are carrying out a study on the gastroduodenal artery. To date (in an examination of 250 consecutive specimens) no case of absence of the gastroduodenal artery has been encountered. It therefore seems probable that cases of absence herein recorded are examples of exceedingly small vessels such as occur when the right gastroepiploic branch arises from the superior mesenteric artery or when the anterior arcuate branch of the inferior pancreaticoduodenal artery has largely taken over the supply to the head of the pancreas and duodenum. Such vessels could have been destroyed during the process of dissection. (B.J.A.)

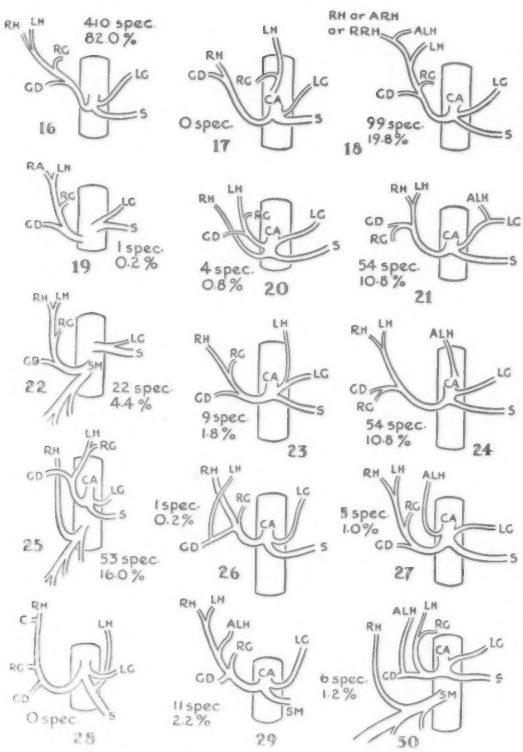
[2]The right gastric artery was destroyed in some specimens; for this reason only completely dependable records are included in the present study.



Figs. 4 to 15. Right hepatic artery (*ramus dexter* of *a. hepatica propria*); variations in origin, diagrammatic.

patic artery, arising in the angle, termed Chalot's triangle, formed by the common hepatic and cystic ducts (Fig. 83). This arrangement obtained in 69.8 per cent of the cases (405 of 580 cystic arteries). The cystic artery crossed ventral to the common hepatic duct (Fig. 81) in 21.2 per cent of the cases (123 of 580) dorsal thereto in 2 per cent (12 specimens). The artery crossed ventral to the common bile duct (Fig. 88) in 3 per cent (17 cases), dorsal to the duct (Fig. 90) in 0.52 per cent (3 cases). In 1.05 per cent (6 specimens) the cystic artery arose from the right hepatic artery in the interval between the right and left hepatic ducts, then coursed from left to right crossing the right hepatic duct anteriorly to reach the gall bladder. In 1.05 per cent (6 cases) the artery arose entirely to the right of the duct system and coursed superiorly to cross the cystic duct anteriorly before reaching the gall bladder. In 0.17 per cent (1 case) encountered, the artery crossed posterior to the cystic duct (Fig. 90). In 1 per cent (5 cases) it arose and coursed entirely to the right of the duct system, crossing neither the common hepatic, cystic, or common bile ducts (Fig. 86). In 0.34 per cent (2 cases) the cystic artery arose as a branch of the right hepatic artery within the portal fissure, from which high point it crossed ventral to the right and left hepatic ducts enroute to the gall bladder.

A single replacing type of cystic artery occurred in 20.8 per cent (120 cases) of the total number of arteries (580). The origin of this vessel was extremely variable. In 30 per cent of these cases (36 specimens), it arose from a replacing type of right hepatic artery derived from the superior mesenteric artery. (Fig. 84); in 22.5 per cent (27 cases) from the left hepatic artery (Fig. 85); in 17.5 per cent (20 specimens) from the right hepatic branch of a replacing type of common hepatic artery derived from the superior mesenteric artery (Fig. 93); in 9.10 per cent (11 specimens) from the common hepatic artery (Figs. 69 and 72); in 10 per cent (12 cases) from an accessory right hepatic branch of the superior mesenteric artery (Fig. 74); in 5 per cent (6 cases) from the gas-



Figs. 16 to 30. Left hepatic artery (*r. sinister* of *a. hepatica propria*); variations in origin, diagrammatic.

troduodenal artery (Fig. 71); in 0.85 per cent (1 case) from the superior mesenteric artery (Fig. 90); in 1.7 per cent (2 cases) from the celiac axis (Fig. 73); in 2.5 per cent (3 cases) from the accessory right hepatic branch of the celiac axis; in 0.85 per cent (1 case) from the superior pancreaticoduodenal artery (Fig. 79), and in 0.85 per cent (1 case) from the right hepatic branch of a replacing common hepatic branch of the aorta.

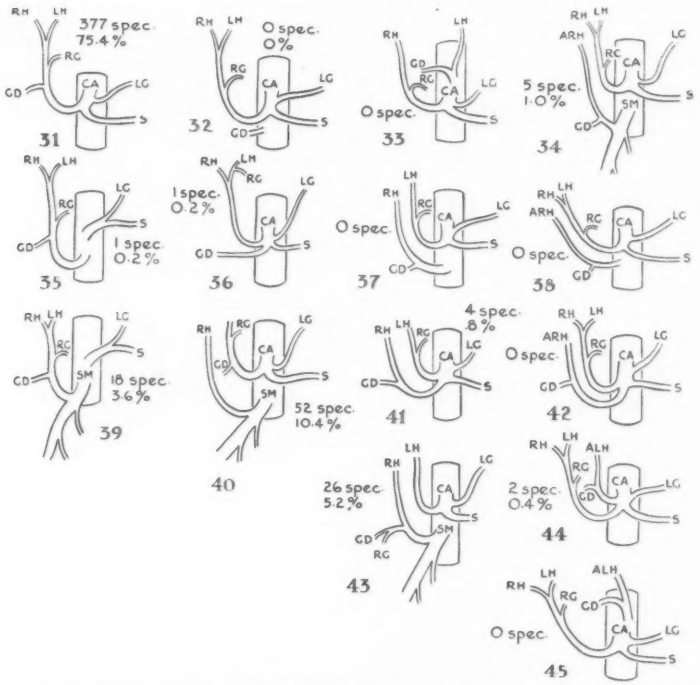
In 3 per cent of the cases (15 specimens) 2 cystic arteries of replacing type were present. In 1.4 per cent (7 of the 15 cases) both cystic arteries were derived from a replacing type of right hepatic artery derived in turn from the superior mesenteric artery, in 0.6 per cent (3 cases) from a replacing type of right hepatic artery and the left hepatic artery. In 0.2 per cent (1 case each) the replacing cystic artery arose from the left hepatic artery (both branches), from the gastroduodenal and accessory right hepatic arteries, from the gastroduodenal and right hepatic branch of the celiac axis artery, from the gastroduodenal and left hepatic arteries, and lastly, from the common hepatic and right hepatic branches of the superior mesenteric artery.

Accessory cystic arteries were present in 11.26 per cent of the cases (65 specimens). In 77 per cent of these (50 of the 65) it arose as a branch of a normal right hepatic artery (Fig. 82); in 9.2 per cent (6 cases) as a branch of the gastroduodenal artery; in 6.25 per cent (4 cases) from the common hepatic artery; in 4.7 per cent (3 cases) from the left hepatic artery; in 3.1 per cent (2 cases) from an accessory right hepatic branch of the superior mesenteric artery.

From the discussion of arterial patterns hereinbefore presented, it has been made evident that the variations in origin of vessels related to the liver are extremely common. Each may vary not only in respect to its own immediate source, but also in respect to derivation of the branch from which it, in turn, may spring. Opportunity for variation would, of course, increase as a particular vessel arose further distalward on the arborizing arterial tree. And, to select two distant extremes, far greater variation would be expected to occur in the case of the cystic artery than in that of the celiac. The cystic artery, in fact, should serve an example, par excellence, of variable channel: arising far from the axially situated aorta, and usually as a branch of a terminal division from a trifid axis aortic in source, it possesses many possibilities of origination.

Theoretically, the cystic artery might arise from either division of the hepatic, the hepatic proper, or from such neighboring vessels, as gastroduodenal, superior pancreaticoduodenal, right gastroepiploic, celiac, mesenteric or abdominal aorta. Figures 67 to 80 illustrate in detail the various sources of origin of the cystic artery.

The simplest pattern of cystic arterial origin is that in which this artery arises as a branch from the terminal portion of the right hepatic artery. Next in order would be origin from the right hepatic artery, but from the more



Figs. 31 to 45. Gastroduodenal artery (*a. gastroduodenalis*); variations in origin, diagrammatic.

proximal portion of that vessel. Then an origin from the distal portion of the hepatic artery proper, before division into right and left hepatic arteries, would be expected to follow in frequency; after that an origin from the left hepatic artery. Further migration down the arterial tree would bring the cystic to arise as a branch of the gastroduodenal artery. Next would be origin as a branch of the common hepatic artery near the latter's source from the celiac axis, then derivation from the celiac itself, with a long devious course to the gall bladder. Spatially more remote would be a right or accessory right hepatic artery, arising not from the celiac axis or common hepatic arteries, but from the superior mesenteric, the cystic branch then being derived from the terminal portion of such an anomalous right hepatic artery. When the common hepatic artery, and its branches, arise from the proximal portion of the superior mesenteric artery or from the aorta itself, the cystic artery could be derived from any portion or branch of this common hepatic trunk, but the most common source would be expected to be the terminal portion of the right hepatic artery. A right hepatic artery derived as a separate and distinct branch from the celiac axis would be regarded as rare. A cystic branch of this anomalous vessel is to be expected in the majority of such cases. Migration downward toward the source branch derived of the aorta, or even from the axial vessel itself could be expected as less frequent patterns, the cystic thus arising from the celiac, superior mesenteric, or aorta itself. In rare instances origin could conceivably take place from the terminal gastroduodenal branches, the right gastroepiploic and superior pancreaticoduodenal arteries, or even from a supraduodenal branch of hepatic or gastroduodenal origin.

Actually, in the 500 specimens examined, examples of all but three of the predictable variations of the cystic artery were seen.

Variations in the arterial pattern of the hepatic pedicle and cystic artery can be best visualized by classifying these arterial patterns into twelve distinct types.

Type I. As might be expected, the commonest arrangement is that in which a hepatic artery of celiac origin divides to supply the right and left hepatic lobes, the gall bladder receiving its cystic branch from the nearer or right division. The cystic artery thus arises as a branch of the right hepatic artery to the right of the common hepatic duct in the angle formed by that structure and the cystic duct. This arrangement was encountered occurring in 58.6 per cent of the cases (340 of 580 cystic arteries). Other authors have recorded an even higher incidence (Belou 70 per cent; Flint 82.5 per cent; Susloff 81.3 per cent; Rossi and Cova 82.3 per cent; Thompson 68 per cent; Lipschutz 65 per cent). Type I could be further divided into subgroups (Ia) in which the right hepatic artery crosses posterior to the common hepatic duct (Figs. 80, 82, 89, and 91) and (Ib) in which it crosses the duct anteriorly (Fig. 83). Type Ia occurred in 47.4 per cent of the cases (275 of the 580 cystic arteries) while type Ib was present in 12.1 per cent of the cases (65 of 580).

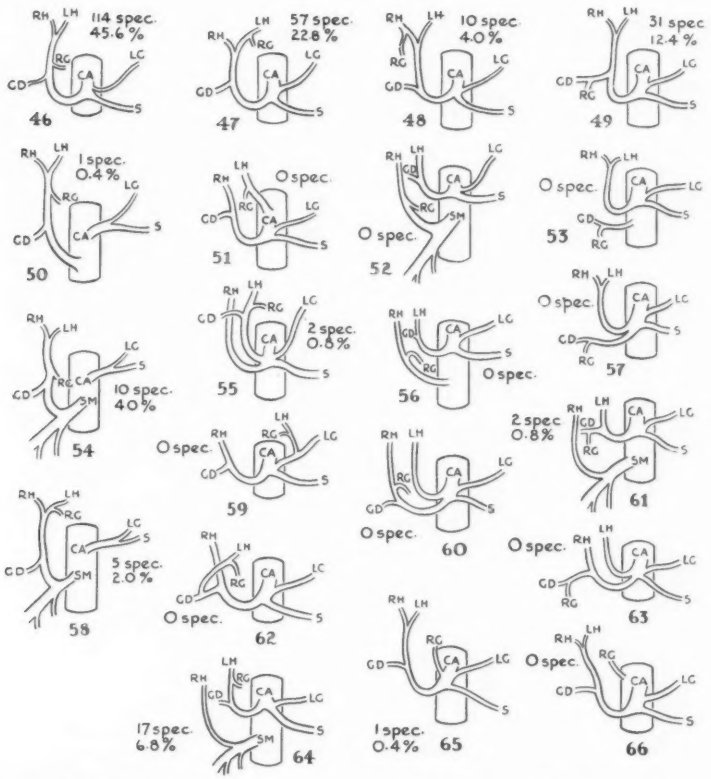
Type II. In type II the cystic artery arises from the proximal portion of the right hepatic artery before the latter has crossed from left to right, dorsal or ventral to the common hepatic duct. The cystic artery then crosses the common hepatic duct anteriorly on its way to the gall bladder and its fossa (Figs. 81 and 92). This arrangement occurred in 13.1 per cent of all cases (76 of 580). The incidence of cystic arteries crossing the anterior aspect of the common hepatic duct is, however, much greater than this, being 21.2 per cent (123 of 580 cases), as compared to Browne's 24 per cent and Thompson's 16 per cent.

Type III. Here the cystic artery originates from an aberrant right hepatic artery derived from the superior mesenteric (Figs. 74 and 84). This pattern occurred in 11.9 per cent of the cases (69 of 580). In an additional 0.8 per cent (4 cases) a right hepatic branch was derived from the superior mesenteric artery, but gave no supply to the gall bladder. In another 4.2 per cent of the cases (21 of 500), it was not the right hepatic artery, but the common hepatic artery (Figs. 75 and 93), which took origin from the superior mesenteric artery. It is of interest to note that in 14 of the cases a dual cystic arterial pattern was present.

Either the right or common hepatic artery may take origin from the superior mesenteric artery without alteration of the vascular relationships in the hepatic pedicle and gallbladder regions. Then again, large right and left hepatic arteries may be found ascending on either side of the common bile and hepatic ducts (Figs. 84 and 93) or crossing beneath the pancreas, duodenum, common bile duct, and portal vein. The right hepatic artery in such cases may cross beneath the cystic duct before giving rise to the cystic artery (Fig. 93) or may give off its cystic branch and then cross beneath the duct (Fig. 87); occasionally it turns to enter the right hepatic lobe without coming into relationship with the cystic duct (Fig. 84). As a general rule it can be stated, however, "that when an aberrant right hepatic artery is encountered, a cystic branch therefrom is to be expected" (Thompson).

Type IV. The cystic artery was derived from the left hepatic artery in 6.2 per cent of the cases (36 of 580). Invariably the cystic artery crossed anterior to the common hepatic duct before reaching and supplying the gall bladder (Figs. 85 and 88). In 25 per cent of the cases (9 of the 36) there was an additional cystic artery present derived from a source other than the left hepatic artery. In 3 per cent (1 specimen) doubling occurred, both branches being derived from the left hepatic artery.

Type V. The cystic artery in type V arose as a branch of the common hepatic artery (Figs. 69 and 72); this occurred in 2.8 per cent (16) of the specimens examined. In 75 per cent of the cases (12 of 16) the artery crossed the biliary duct system anteriorly while in 18.7 per cent (3 cases) it crossed posterior to the common hepatic duct and anterior to the portal vein. In 6.3 per cent (1 case) the cystic artery was derived from the proximal portion of a common hepatic artery of replacing type, the latter originating from the superior mesenteric artery. This cystic artery then crossed posterior to both the common bile duct and


RH LH 114 spec. 45.6% RG LC CA GD S 46
RH LH 57 spec. 22.8% RG LC CA GD S 47
RH LH 10 spec. 4.0% RG LC CA GD S 48
RH LH 31 spec. 12.4% LC CA GD RG S 49
RH LH 1 spec. 0.4% RG LC CA GD S 50
RH LH O spec. LC CA GD RG S 51
RH LH LC GD CA S RG SM O spec. 52
RH LH O spec. LC CA GD RG S 53
RH LH RG LC CD CA 2 spec. 0.8% S 55
RH LH LC GD CA S RG O spec. 56
RH LH O spec. LC CA GD RG S 57
RH LH LC S RG CA GD SM 10 spec. 40% 54
RH LH RG LC CA GD S O spec. 59
RH LH CD CA LC RG SM S 2 spec. 0.8% 61
RH LH RG LC CA S GD SM 5 spec. 2.0% 58
RH LH RG CA LC GD S O spec. 62
RH LH RG GD CA LC S O spec. 60
RH LH LC CA GD RG S O spec. 63
LH RH RG CD CA LC S SM 17 spec. 6.8% 64
RH LH RG GD CA LC S 1 spec. 0.4% 65
RH LH RG O spec. CD CA LC S 66

Figs. 46 to 66. Right gastric artery (*a. gastrica dextra*); variations in origin, diagrammatic.

portal vein before ascending to the right of these structures to reach the gall bladder and its fossa. In 81 per cent (13 of the 16), the cystic artery arose from the common hepatic artery near its bifurcation into right and left hepatic arteries (Fig. 69), while in 19 per cent (the remaining 3 cases) it formed a long slender branch arising from the proximal portion of the common hepatic artery (Fig. 72).

Type VI. The cystic artery took origin from the gastroduodenal artery (Figs. 71 and 88) in 2.6 per cent of the cases (15 of 580). In 73.3 per cent of these (11 of the 15), the cystic artery arose from the proximal portion of the gastroduodenal artery, lying to the left of the common bile duct. In all of these instances the cystic artery was long and slender. In only 1 case did the artery ascend to the left of the common bile duct; in the others it crossed the duct anteriorly attaining its right side before ascending to the gall bladder. In 53.3 per cent (8 of the 15 cases) there was an additional cystic artery present derived from a source other than the gastroduodenal artery.

Type VII. In only 0.4 per cent (2 cases) in the present series, the cystic artery arose as a branch of the celiac axis (Fig. 73). In both specimens it was a long slender twig which crossed to the right, posterior to the common bile duct and portal vein, then ascending on their right to reach the gall bladder. In both cases the artery formed the sole source of supply to the gall bladder.

Type VIII. In 3 cases in the present series (0.6 per cent) the cystic artery was derived from a replacing or from an accessory type of

right hepatic artery, the latter derived in turn from a source other than the superior mesenteric artery. In several specimens the right hepatic artery arose as a branch of the celiac axis.

Type IX. In but 0.2 per cent of the specimens (1 case) the sole source of arterial supply to the gall bladder was a long, slender cystic artery derived from the first portion of the superior mesenteric artery (Figs. 76 and 90). In ascending it crossed posterior to the duodenum, pancreas, portal vein, and common bile duct, to attain the right side of the hepatic pedicle, and then to pass upward beneath the cystic duct to the gall bladder.

Type X. In 0.2 per cent (1 case) the cystic artery took origin from the superior pancreaticoduodenal (Fig. 79). The artery was long and slender; arising to the right of the common bile duct, it passed almost vertically upward to the gall bladder.

Type XI. Lipschutz has reported 2 cases in which the cystic artery originated as a direct branch from the aorta (Fig. 77). Examples of such an unusual origin were not encountered in the present series.

Type XII. A single case has been reported by Kosinski in which the cystic artery arose as a branch of the right gastroepiploic artery (Fig. 78). No such specimens were encountered in the present series.

Origin of the cystic artery from any arterial branch arising to the left of the abdominal aorta has not been reported by others or seen by the present authors.

Double and triple cystic arteries. Doubling of the cystic artery is relatively common, occurring in 15.6 per cent of the cases (78 of 500). The source of these dual cystic arterial branches is quite variable. Both branches (Fig. 82) are most commonly derived from the right hepatic artery (57 cases). However, branches from the left hepatic (Fig. 88), from the common hepatic and from the gastroduodenal arteries (Figs. 86 and 88) also occur in a decreasing order of frequency.

In a single specimen of the current series, three cystic arteries were present, all branching from the right hepatic artery; two arose to the right of the common hepatic duct after the source vessel had crossed beneath the duct; the third, coming from the right hepatic artery to the left of the common hepatic duct, crossed anterior to the duct to supply the anterior surface of the gall bladder. Two such cases have been reported previously, one by Brewer and one by Browne, making a total of only 3 cases in almost 2000 specimens examined.

In one specimen, representing a type not previously described, two cystic arteries were present, the first derived from the left hepatic artery near the bifurcation of the common hepatic artery, the second from the right hepatic artery just beyond the point of crossing behind the common hepatic duct (Fig. 89). The two cystic arteries then fused to form a common trunk which coursed along the upper and posterior border of the cystic duct to the neck of the gall bladder where the conjoined channel again divided into branches supplying both surfaces of the gall bladder and its fossa.

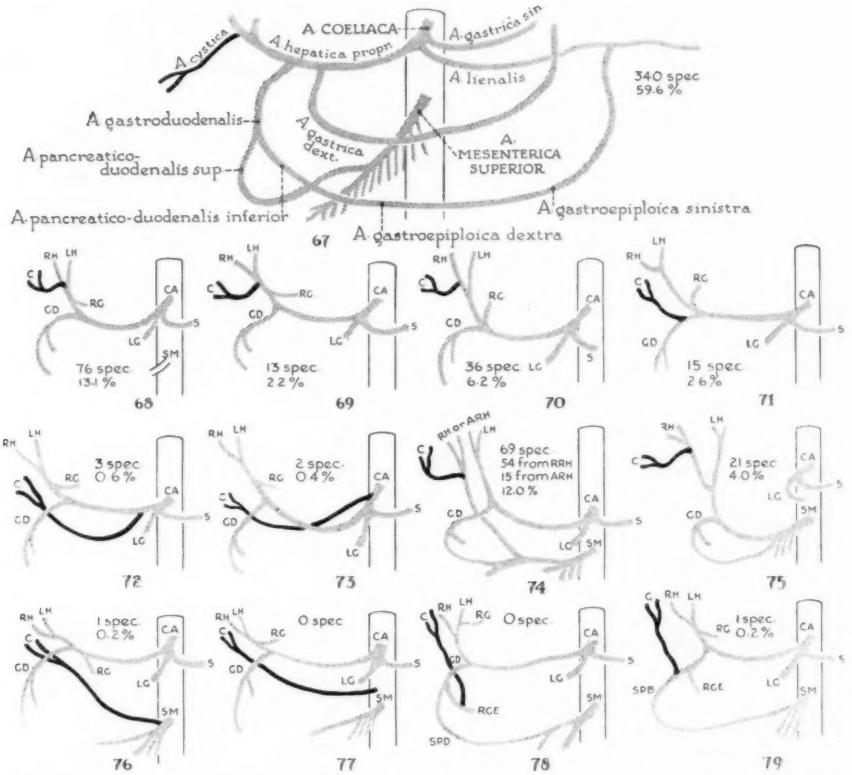
To facilitate our study of the hepatic pedicle, the authors have endeavored to depict the sources from which the common, right and left hepatic, gastroduodenal and right gastric arteries might theoretically arise. Diagrammatic Figures 1 through 66 serve this purpose.

The common hepatic artery may be derived from the celiac axis (Fig. 1), the aorta (Fig. 2) or the superior mesenteric artery (Fig. 3). When the common hepatic artery is absent, the right and left hepatic arteries may arise from other sources (Figs. 5, 9, and 13).

The right hepatic artery may arise as a branch of a normal or replacing type of common hepatic artery, from the superior mesenteric artery, aorta, celiac axis, left hepatic, or gastroduodenal arteries (Figs. 4 through 15).

The left hepatic artery may arise as a branch of a normal or of a replacing common hepatic artery; a replacing type of left hepatic artery may arise as a branch of the aorta, celiac axis, left gastric, splenic, or gastroduodenal arteries; accessory left hepatic arteries may arise as branches of the common hepatic, right hepatic, left gastric, aorta, celiac axis, splenic or gastroduodenal arteries (Figs. 16 through 30).

The gastroduodenal artery may arise as a branch of a normal or replacing common hepatic artery or it may also arise from any of the following arteries: the celiac axis, replacing



Figs. 67 to 79. Cystic artery (*a. cystica*); variations in origin, diagrammatic. In addition to the origins here depicted, the cystic also arose in 3 instances from an accessory or a replacing type of right hepatic artery, the latter derived, in turn, from the celiac (bringing the total number of cystic arteries studied to 580).

or accessory left hepatic, replacing or accessory right hepatic or the aorta (Figs. 31 through 45).

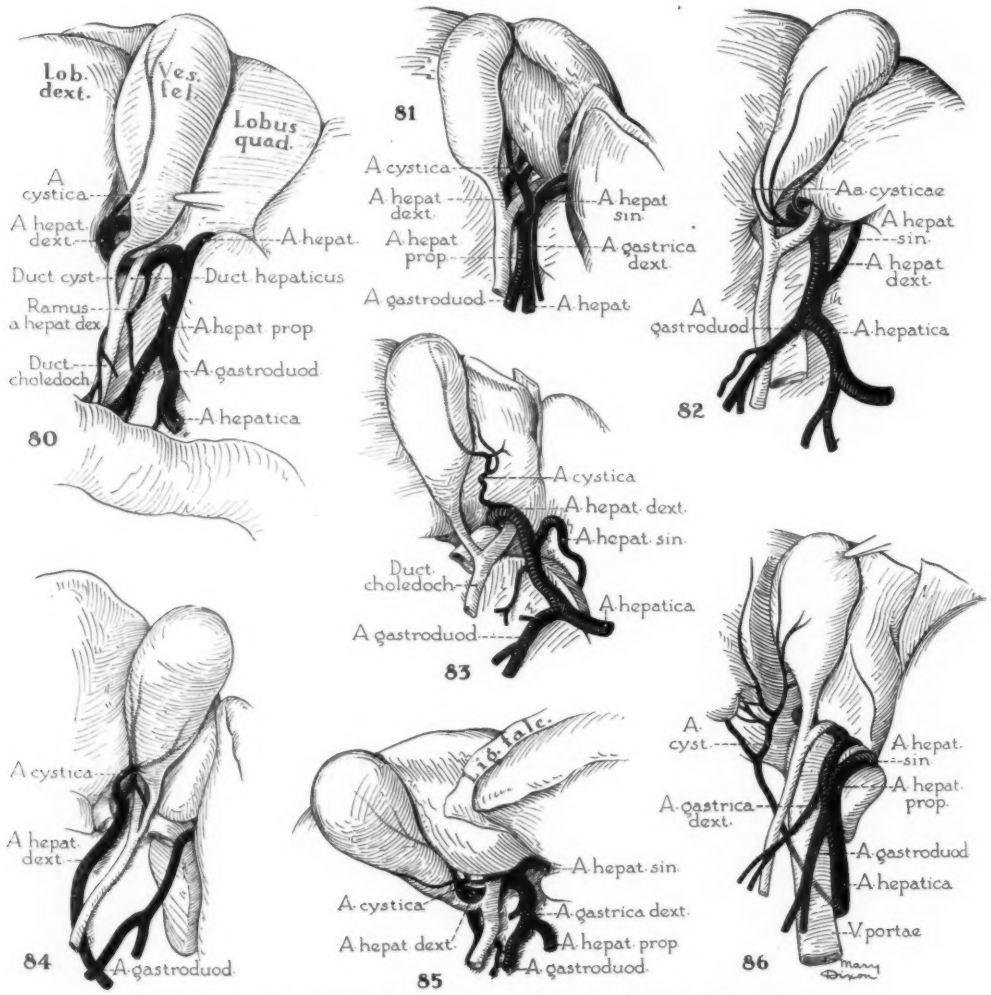
The right gastric artery may be derived as a branch from a normal or replacing common hepatic artery, as a branch of a normal, replacing or accessory right or left hepatic artery, as a branch of a normal, replacing or accessory gastroduodenal artery or as a direct branch of the celiac axis or abdominal aorta (Figs. 46 through 66).

Selected cases. While types of arterial source and branching may be conveniently shown by simplified diagrams (Figs. 1 through 79), pictorial records of actual specimens are required for full appreciation of the precise form, course, and relations of surgically important structures. Some selected and, to a degree, typical cases will be discussed in association with drawings prepared in the dissection room.

Figure 80: The cystic artery arose from the right hepatic artery in the angle bounded by the cystic and common hepatic ducts, gall bladder retracted to the left. The right hepatic artery crossed posterior to the common hepatic duct, where it gave rise to a small branch which entwined the common bile duct.

Figure 81: The cystic artery arose from the proximal portion of the right hepatic artery to the left of the common hepatic duct. It crossed the hepatic duct anteriorly, after giving off a small branch to the quadrate lobe of the liver, it coursed along the anterosuperior border of the cystic duct to the gall bladder.

Figure 82: The larger of two cystic arteries arose from the right hepatic artery after the latter had crossed posterior to the common hepatic duct; dividing immediately upon reaching the gall bladder, its



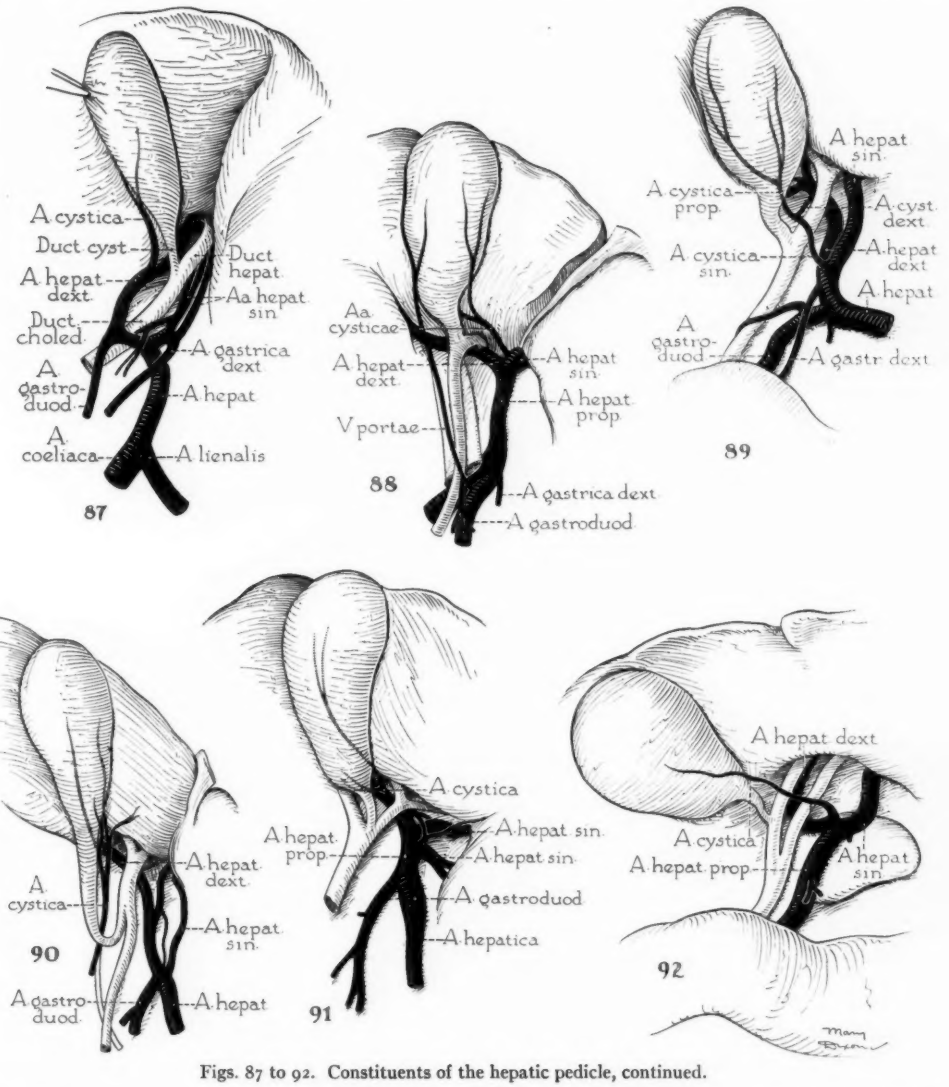
Figs. 80 to 86. Constituents of the hepatic pedicle; prepared from individual dissections.

branches supplied the anterior surface of the gall bladder and right half of its fossa. The other cystic artery arose from the right hepatic artery to the left of the common hepatic duct; supplying two small twigs to the quadrate lobe, it then coursed to the right crossing posterior to the hepatic duct to supply the hepatic surface of the gall bladder and the left half of its fossa.

Figure 83: The cystic artery arose to the right of the common hepatic duct from a right hepatic artery which crossed anterior to the common hepatic duct.

Figure 84: A common hepatic artery is wanting. The left hepatic artery arose as a branch of the celiac axis; coursing upward to the left of the common bile and hepatic ducts it lay on the anterior surface of the portal vein. The right hepatic artery, derived from the first portion of the superior mesenteric artery, passed obliquely upward and to the right, first posterior to the portal vein and common bile duct, and then to the right of the common bile duct. Just before entering the right hepatic lobe, it gave rise to a large cystic branch to the hepatic surface of the gall bladder.

Figure 85: The cystic artery originated from the proximal portion of the left hepatic. It then coursed transversely from left to right, lying in close associa-



Figs. 87 to 92. Constituents of the hepatic pedicle, continued.

tion to the anterosuperior surface of the cystic duct after having crossed the hepatic duct anteriorly. En route to the gall bladder, after having furnished two small branches to the quadrate lobe, it divided at the neck of the gall bladder into its terminal branches to supply both surfaces of the vesicle.

Figure 86: The cystic artery arose as a branch derived from the first portion of the common hepatic artery. The cystic artery ascended to the right, crossing posterior to the common bile duct and portal vein. It gave rise to several small twigs to the right hepatic lobe before eventually reaching and supplying the gall bladder and the tissues in its fossa.

Figure 87: A short common hepatic arterial trunk gave off to the left of the ductus choledochus a left hepatic artery, which immediately divided into the following four branches: the right gastric artery, two left hepatic branches, and a small twig to the common bile duct. The right hepatic artery crossed anterior to the common bile duct and there gave rise

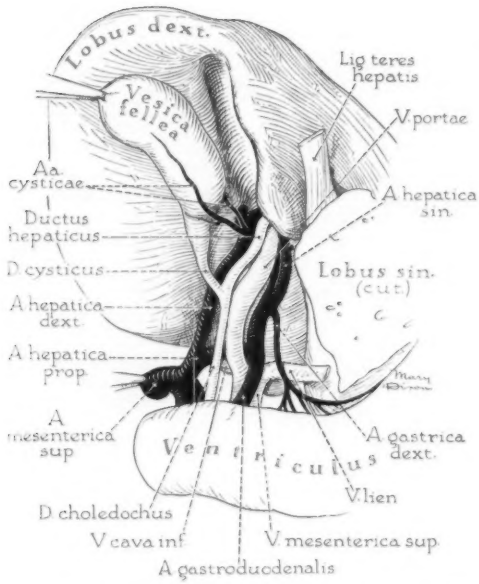


Fig. 93. Constituents of the hepatic pedicle, concluded.

to the gastroduodenal artery before ascending to the right of the common bile and hepatic ducts. It gave rise to the cystic artery and then passed posterior to the cystic duct to enter the right hepatic lobe.

Figure 88: The cystic artery arose as a branch of the gastroduodenal. Coursing vertically upward, it crossed anterior to the common bile duct to reach the right half of the gall bladder and adjacent portion of the fossa. A second cystic branch of the left hepatic artery was also present: it coursed transversely from left to right, crossing anterior to the common hepatic duct to supply the left half of the gall bladder and fossa. This vessel closely matched the cystic duct in its course, while the gastroduodenal branch similarly accompanied the common bile duct.

Figure 89: A rare example of dual cystic arteries, fused distally to form a single terminal trunk. The larger and longer branch was derived from the left hepatic artery near its origin. Crossing anterior to the common hepatic duct, it fused with the second cystic branch derived from the right hepatic artery in the triangle of Chalot. The common trunk then coursed along the posterosuperior border of the cystic duct to the neck of the gall bladder and there divided into its terminal branches.

Figure 90: The cystic artery, derived from the proximal part of the superior mesenteric, crossed posterior to the portal vein and common bile duct to ascend to the right of the latter structure. Near its termination the artery passed in an upward direction beneath the cystic duct to reach the neck of the gall bladder.

Figure 91: A large accessory right hepatic duct entered the common bile duct just distal to that of fusion of the cystic and common hepatic ducts. The cystic artery was derived from the right hepatic artery after the latter had crossed posterior to the common hepatic duct.

Figure 92: The cystic duct drained directly into the right hepatic duct (the common hepatic duct being absent). The cystic artery arose as a branch of the most proximal portion of the right hepatic artery; it crossed in front of the right and left hepatic ducts to reach the gall bladder.

Figure 93: A short common hepatic artery from the superior mesenteric divided into right and left hepatic branches. The right branch crossed posterior to the common bile duct and portal vein, and then ascended to the right of these structures, crossing posterior to the cystic duct before giving off a short cystic branch and dividing into its two terminal branches. The left branch ascended to the left of the common bile duct and portal vein passing posterior to the splenic vein before giving rise to a large gastroduodenal and small right gastric artery. Terminally it divided into two terminal branches to the liver hilus.

B. BILIARY DUCT SYSTEM

In their major features, the extrabiliary ducts and the gall bladder are remarkably constant. Boyden (1926) in a survey involving 10,000 domestic animals and 19,000 cadavers found comparatively few major variations. Chief among these were the following: (1) cleft gall bladders which originate by subdivision of the primary cystic diverticulum; (2) diverticular bladders (vesicles or subordinate lobes which arise as buds from the neck of the embryonic gall bladder); (3) ductular bladders (supernumerary vesicles derived from either the hepatic, cystic or common bile ducts and encountered chiefly in humans); (4) trabecular bladders (vesicular outgrowths of the liver trabeculae bordering the gall-bladder fossa and occurring as rare anomalies of cattle, sheep, and perhaps humans); (5) pancreatic bladder (a rare anomaly originating as an outgrowth from the pancreatic tissues occurring in the cat).

Embryologically the biliary duct anomalies encountered in the present study can best be explained on the basis of changes occurring in the hepatic antrum, a dilatation or vestibule at the upper end of the embryonic choledochus into which all the ducts of the liver, including the cystic duct, empty. In the present series (500 cases) only 12 major anomalies of the

duct system were encountered, an incidence of but 2.4 per cent. This figure is astonishingly low when compared with the large number of extreme variations in the vascular supply.

In a single specimen (Fig. 91) an accessory right hepatic duct entered the common bile duct 5 millimeters distal to the junction of the cystic and common hepatic ducts; in three specimens encountered, the common hepatic duct was wanting, the cystic duct draining directly into the right hepatic duct (Fig. 92); three examples of an accessory right hepatic duct which drained into the cystic duct were seen; two cases of cholecystohepatic duct, in which a small accessory duct from the right hepatic lobe drained directly into the gall bladder, were met with; a small hepatic duct from the right or quadrate lobes of the liver which drained into the common hepatic duct in addition to the regular right and left hepatic ducts was encountered twice; in a single case, the cystic, right and left hepatic ducts joined together at a common point of fusion so that no common hepatic duct existed.

Three modes of union of the cystic and common hepatic ducts have been described by Eisendrath (1920): the angular, the parallel, and the spiral. All three modes of union were encountered with varying frequency in the present series but such variations were not considered as major anomalies of the duct system and were therefore not recorded.

Surgical Commentary

The increasing number of operations performed for obstructive jaundice and biliary fistula due to man-made injuries of the common bile duct and the hepatic ducts calls for a more detailed knowledge of the blood vessels in the gastrohepatic region. The degree of variation in the vascular pattern encountered in this area is of vital importance to the surgeon concerned with the techniques employed in radical pancreaticoduodenectomy. Dennis and Varco (1946) have described a case of carcinoma in the head of the pancreas associated with a hepatic artery which arose from the superior mesenteric artery and traversed the head of the neoplastic gland. Pancreaticoduodenectomy was performed, an operation which necessitated resection and reanastomosis of the hepatic artery; the patient, however, failed to survive this procedure.

Since variations in the biliary tree and its associated vascular elements are so frequent, it is advisable to identify major structures in this area before surgery is attempted. Adequate exposure is essential. Introduction of the hand between the right hepatic lobe and the diaphragm will allow air to come between these surfaces; by this means the right lobe is pushed downward into lower abdominal position. If necessary, greater mobilization of the liver can be obtained by cutting the round ligament and its falciform investment between ligatures.

In the performance of cholecystectomy the cystic duct should be carefully dissected from the adjacent fibrous and fatty tissue in order to expose its full course from the gall bladder to juncture with the common hepatic duct. McWhorter (1923) is of the opinion that exposure may be facilitated by incising the peritoneum along the right side of the body of the gall bladder. Then, by lifting and rotating the gall bladder to the left, it may be peeled away from the liver. The left peritoneal fold, with its contained cystic arterial branches, is thus readily freed. Identification of the cystic duct and artery is often rendered difficult by adhesions and by adjacent areas of inflammation.

The observations herein recorded point to the hazard of ligating the cystic artery and duct with a single tie. The course of the cystic artery is so variable, and the occurrence of dual branches so common, that careful examination of the fatty tissue immediately behind the cystic duct, with separate ligation of the artery, seems essential. Ligation of the cystic duct at a point 1 to 2 centimeters proximal to its juncture with the common hepatic and bile ducts is also advisable. Unless this precaution is taken, tenting of the common duct, with pinching of its wall by the ligature, can easily result.

Jackson (1938) stated that the major cause of injury to the ducts is hemorrhage from a divided cystic artery or an anomalous arterial stump. He believes that the surest way to avoid this danger is to proceed in such a way as to identify and ligate the cystic artery before dividing the cystic duct. He feels that,

because the artery frequently is anomalous in position, is often larger than expected, and is not uncommonly multiple, it is important to clamp, divide, and ligate all tissues of the area, as if it were actually established that such anomalies were present. In the presence of cystic arterial hemorrhage, he has outlined the steps necessary to control bleeding, chiefly by means of pressure on the common hepatic trunk (with the index finger inserted into the epiploic foramen).

Eisendrath (1918) has emphasized the frequency with which the right hepatic artery lies in close approximation to the cystic duct (cf. current Figs. 80, 81, 85, 87, and 88). Such position renders the artery particularly vulnerable to injury during cholecystectomy, whether the dissection begins at the fundus of the gall bladder or at the cystic duct.

In choledochostomy, the common occurrence of vessels intimately associated with the common bile duct would be taken into account (Figs. 80, 84, 85, 87, 88, 89, and 93). Injury to these structures may result in troublesome hemorrhage and subsequent injury to the common bile or hepatic ducts, or even in inadvertent ligation of the right or common hepatic arteries with resultant hepatic infarction, necrosis and so called "liver death." In recent years opinion has been divided as to whether or not true infarction and necrosis would result, in man, from ligation of the right, of the left, or even of the common hepatic artery. Certainly the major portion of blood going to the liver is carried by way of the portal system. This, however, is venous blood with a low oxygen content. It is evident from the present study that before a dependable conclusion can be reached, the physiological importance of the frequently occurring hepatic arteries (of both replacing and accessory types) must be determined. In any event, the surgeon should ascertain whether such vessels exist before undertaking ligation of the hepatic arteries.

Variations in the duct system, although rare in man, can be the basis of serious and even fatal complications. Severance of an anomalous hepatic duct (Fig. 91), would result in bile peritonitis. This complication is especially likely to occur when small accessory bile ducts drain into the cystic duct or directly into the gall bladder. Neuhoff and Bloomfield (1945) have reported two cases of cholecystohepatic duct; in one of the cases failure to ligate caused a biliary fistula of 45 days duration. One of the present authors has seen three additional instances of this anomalous duct.

The surgeon might readily encounter difficulty in identifying and exposing the common bile duct. It has been regularly taught that this structure is sufficiently avascular in its supraduodenal portion to allow safe exposure by incision through the overlying peritoneum. However, the fallacy of such teaching becomes evident when it is remembered that the right hepatic artery (7 cases) or the cystic artery (17 cases) may cross anterior to the common bile duct, and that small arterial branches accompany and entwine the duct (Figs. 80, 85, and 88). The frequent occurrence of a major arterial trunk situated to the right of the common duct (90 cases) calls for extreme caution in exposing the duct from this approach. Preliminary palpation, and if necessary, exploration by aspiration (with a syringe and small needle) is advisable. Certainly, before any procedure involving the biliary ducts is attempted, a thorough search for anomalous hepatic vessels and their branches is surgically desirable (Figs. 80, 84, 85, 87, and 93).

Summary

1. In a study of 500 cadavers, the arterial patterns and modes of variation of the common hepatic artery and its branches have been reported.

2. The relationship of these arterial trunks and branches to the biliary ducts have likewise been reviewed in detail.

3. On the basis of site of origin, the cystic artery has been classified into 12 types and their number and percentages of occurrence recorded.

4. Two rare and unusual patterns of cystic arterial variation, triplication and fusion, have been presented.

5. A brief résumé has been made of the abnormalities encountered in the biliary duct system.

6. The application of these findings to the surgery of the gall bladder, common bile duct,

pancreas, and duodenum has been discussed. Recommendations have been made which should facilitate detection of anomalous vessels and ducts and, as a consequence, aid in protecting such structures from inadvertent surgical trauma.

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AIR ARTHROGRAPHY OF THE KNEE JOINT

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RECENTLY there has been a series of papers on air arthrography, or pneumoroentgenography as the Americans prefer to call it, of the knee joint. This appears to indicate a revived interest in a method which is now many years old, and as far as cartilage injuries have been concerned, it has been the general custom to belittle. True, the experienced few have found it of great assistance, but there has been no general acknowledgment of its value as an ancillary method of investigation. The conditions under which we were working suggested that its employment might be of value, as, owing to language difficulties, the detailed history so necessary to an accurate diagnosis could not be obtained from many Indian troops. They themselves lacked the vocabulary and the observation to describe accurately what they felt, and the interpreters available acted more as a baffle than a link between the surgeon and the patient. A short cut to accurate diagnosis, if available, was thus desirable, and it was decided to explore the value of air arthrography.

There was also the usual series of doubtful cases in British troops in whom positive or negative evidence by an ancillary method would be of value in helping to decide immediate disposal. In order to obtain the necessary experience in the method, it was decided to submit all patients, whether or not a diagnosis could be made clinically, to air arthrography, to obtain, in particular, the benefit of comparing the arthrographic findings with those at operation.

Commenced with open views as to its value, and in an experimental frame of mind, the method, in our hands, has grown to be extremely reliable, and a very valuable additional line of investigation. This is due in part to an improvement in technique, and in part to increased experience in the interpretation of the roentgenograms. Unquestionably, the most important factor in the accuracy of the method is the quality of the roentgenogram produced, and it is probable that the poor opinion of the method, often expressed, is due to the defective films submitted for interpretation.

METHOD

After a 24 hour preparation of the knee, the patient is taken to the theater, and, under full aseptic precautions, the joint is filled with air. As much air as possible is introduced and the quantity which can be introduced varies markedly from knee to knee; the more air introduced, of course, the better the visualization of the cartilage produced. At first, unfiltered room air was used and a device was arranged to introduce air filtered through cotton wool. No reaction, however, having occurred in the early cases, the use of unfiltered room air has been continued with no untoward results. The delay in the absorption of the air from the joint is both an advantage and a disadvantage; an advantage in that unsatisfactory films can be repeated on one filling, a disadvantage in that it takes 5 days for the air to absorb, and the physical signs in the joint are obscured during this period, though the patient is in no discomfort. It has become our practice, however, to follow the arthrography, where positive, by arthrotomy 2 days later, thus effectively removing the air.

Under local anesthesia, and by means of a lateral approach to the suprapatellar pouch, the joint is first emptied of any effusion, and then filled with air. At first, in order to minimize discomfort, a few cubic centimeters of novocain were introduced into the joint, but it was found that there was little pain from the introduction of the air, the most painful part being the infiltration of the synovial membrane with the anesthetic, and this was discontinued. It is not always as easy as it appears to enter an undistended suprapatellar pouch, the size of which varies enormously from patient to patient. A small amount of effusion makes the puncture much easier, but complicates the

Fig. 1. Method of roentgenography. Firm pressure is applied to the foot to open the joint as much as possible.

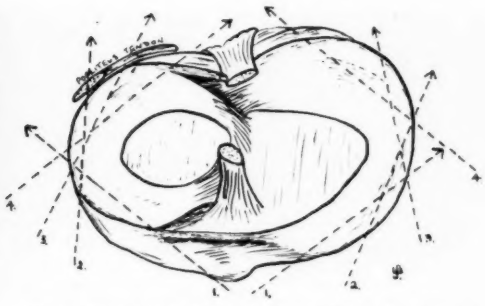

Fig. 2. Upper end of tibia with cartilages showing projections employed.

procedure by requiring a needle of moderate size for its evacuation, thus providing a small channel for the escape of the air. With a small bore needle, the air can be introduced faster than it can escape, and no valve is required; with a large-bore needle, it is necessary to use a valve, or a two-way tap. The knee is distended until it feels firmly elastic to the touch, and the needle is rapidly withdrawn; finger pressure is applied to the puncture to prevent escape of air, and then the suprapatellar pouch is firmly bandaged to distend more fully the lower part of the joint.

It was noticed that knee joints vary very much in their capacity. In some, 60 cubic centimeters was the maximum it was possible to introduce, in others 150 cubic centimeters. As the amount of air that it is possible to introduce materially affects the quality of the films, some indication is obtained at once as to the quality of the roentgenogram likely to be produced. Further, the "tight" knee joint presents added operative difficulties, since retraction is more difficult. It is to be noted that the only case in which a tear was not diagnosed roentgenologically occurred in a case in which the knee joint filled badly, and that this, plus the type of tear, rendered diagnosis by roentgenography extremely difficult.

ROENTGENOLOGICAL TECHNIQUE

In the absence of any information on this subject, we commenced our investigation by the use of two oblique views of each meniscus, with a normal knee joint exposure at 30 inch anode film distance. We were, however, dissatisfied with the quality of the films obtained and would probably have abandoned the method if a paper in the *American Journal of Roentgenology* by J. Garston Cohen, describing a "Vacuum Technic in the Demonstration of the Menisci" had not come to our attention. In this method, the knee was forcibly adducted or abducted over sandbags, and the x-rays directed through the opened-up half of the joint parallel to the table top. The pictures reproduced, however, were unconvincing, and we decided to try a similar projection, having previously introduced air into the joint, and adducting or abducting the knee over the sandbags with a firm pressure of the hand, insufficient to cause discomfort to the patient (Fig. 1). We also decided to use a long dental cone to facilitate centering, the anode film distance being reduced to 24 inches. It also appeared obvious that the larger the number of views taken of each meniscus, the more likelihood there was of the lesion being detected, and it is now our practice to take four oblique views, all in the anteroposterior plane, of the meniscus under suspicion (Fig. 2). The improvement in the roentgenograms and in their diagnostic value was remarkable, and since the adoption of this hybrid technique, air arthrography has become, for us, a valuable adjunct to clinical methods.

The final technique evolved comprises four oblique views, taken anteroposteriorly through the joint, with the central ray passing as nearly as possible parallel to the surface of the tibial plateau, and with the knee positioned over two sandbags and under firm lateral strain to open

Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Fig. 3 The normal lateral cartilage, anterior horn.
Fig. 4. The normal lateral cartilage, middle third. Note the attachment is thinner than the cartilage.
Fig. 5. The normal lateral cartilage, showing the semicircular shadow of the popliteus canal.
Fig. 6. The normal lateral cartilage, posterior horn, showing the bifid attachment of the cartilage above and below the popliteus tendon.

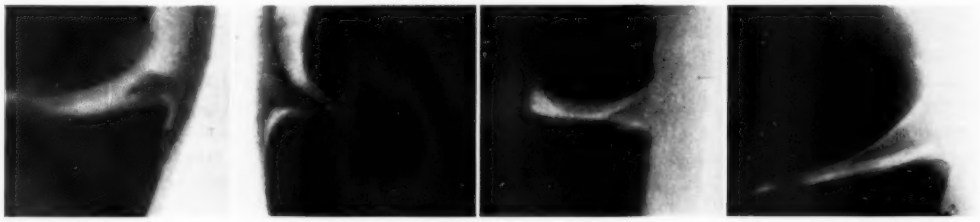

Fig. 7. Fig. 8. Fig. 8a. Fig. 9.

Fig. 7. The normal medial cartilage, anterior horn.
Figs. 8 and 8a. The normal medial cartilage, middle third.
Fig. 9. The normal medial cartilage, posterior horn.

up the compartment under investigation, the rays being directed roughly horizontal to the table top. The obliquity of the views is judged by eye as near as possible to those shown in Figure 2, in which it will be noticed that they vary for each meniscus. A long dental cone, throwing a 5 inch diameter field at 24 inches, is used, and care is taken to see that the tibial spines are included in the field. Two and a quarter seconds' exposure is used with intensifying screens, and blue brand or red seal film, at 15 milliamperes and 47 kilovolt peak.

NORMAL CARTILAGE APPEARANCE

Lateral meniscus. This is attached anterolaterally to the joint capsule, at the level of the lower end of the femur, so that the arthrograph of the anterior horn shows a large air space under the cartilage, the shadow of which passes downward and medially and tapers off evenly toward the center of the joint (Fig. 3). Laterally, the attachment is a little thinner than the cartilage itself, but once between the bones the cartilage tapers off smoothly, as before (Fig. 4).

Posterolaterally and posteriorly, the air in the sheath of the tendon of popliteus, which separates the outer edge of the meniscus from the fibula collateral ligament, complicates the picture. The cartilage insertion appears wider and a semicircle of air, concave medially, is seen crossing it a little medial to its insertion (Fig. 5). More posteriorly, the air shadow becomes concave laterally, and lies actually in the insertion of the cartilage to the joint capsule, the cartilage thus being attached by two fine bands, one above and one below the sheath (Fig. 6). In these posterior oblique views, and occasionally in the true anteroposterior view, the anterior horn of the cartilage may be seen curving up behind the femoral condyle and then down again as it tapers off toward its medial attachment.

Medial meniscus. The shadows thrown by this cartilage are less complicated than those of the lateral. Anteriorly the meniscus has a

Fig. 10. Fig. 11. Fig. 12.

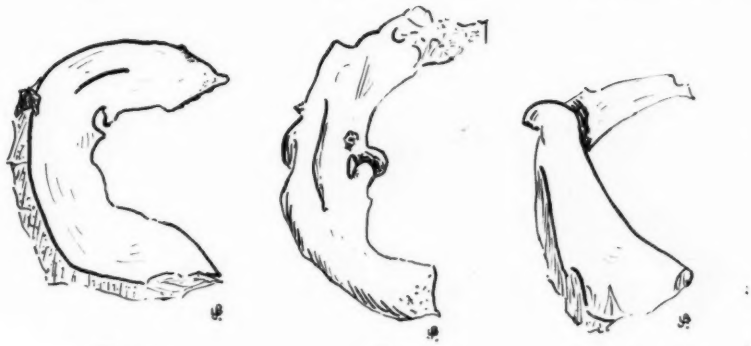

Fig. 10a. Fig. 11a. Fig. 12a.

Fig. 10. Lateral cartilage, showing central tags.
Fig. 10a. Sketch of cartilage removed at operation.
Fig. 11. Lateral cartilage with central tags.
Fig. 11a. Sketch of cartilage removed at operation.

Fig. 12. Lateral cartilage showing horizontal split and nodule, with a cartilage erosion above it.
Fig. 12a. Sketch of cartilage which was removed at operation.

narrow attachment, widens a little, and then narrows to a point, thus appearing to have an oval shape in cross-section. Passing laterally its attachment widens to the same thickness as the cartilage itself, the shadow of which now tapers off smoothly across the joint. Posteriorly, the attachment is wider than the cartilage, the body of which tapers evenly as it passes between the condyles of the two bones.

CRITERIA OF ABNORMALITY NOTED

Lateral meniscus. The complexity of the shadows cast by this cartilage, until its peculiarities are mastered, makes diagnosis of lesions more difficult than those of medial meniscus.

The following points were noted in connection with the abnormal lateral cartilage: (1) irregularity of the cartilage surfaces (Figs. 10 and 11), in cases of tags and reduced "bucket handles," (2) additional shadows in the lateral or medial compartments of the joint (Fig. 12) in cases of displaced portions of cartilage or "bucket handles," (3) extension or widening of the air-space between the cartilage and the tendon of popliteus (Fig. 13) in posterior tears; (4) loss of any substance from the cartilage in displaced tears and "bucket handles"; (5) thickening of cartilage insertion to joint capsule in cases of cyst formation (Fig. 14).

Lack of alignment of lateral edge of femoral and tibial condyles is common and is not considered by us of any diagnostic significance.

Medial meniscus. The following points are noted in connection with the medial meniscus: (1) loss of substance from the cartilage with or without extra shadows in the medial compartment of the joint indicating displaced "bucket handle" (Figs. 15 and 16); (2) irregularity of either surface of the cartilage (Fig. 17); (3) fine linear air-spaces in the cartilage, indicating undisplaced tears, which may be partial or complete (Fig. 18); (4) thickening of the

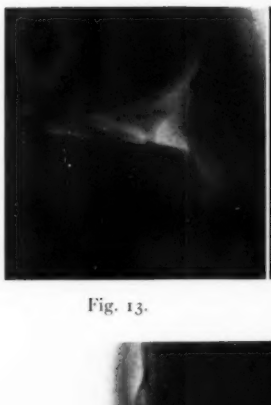

Fig. 13.

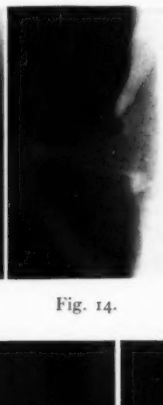

Fig. 14.

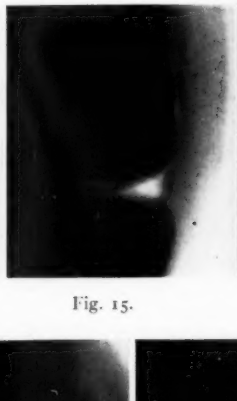

Fig. 15.

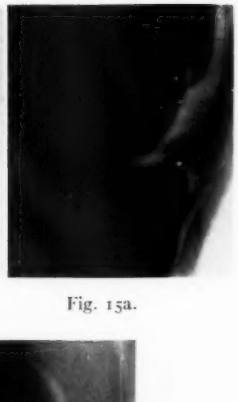

Fig. 15a.

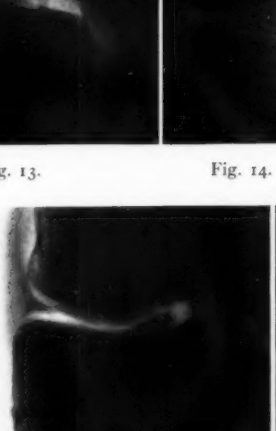

Fig. 16.

Fig. 17.

Fig. 17a.

Fig. 18.

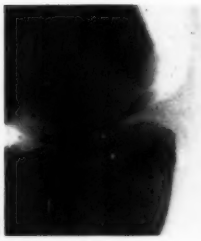

Fig. 19.

Fig. 13. Extension of the normal air space, with loss of attachment of the posterior third of the cartilage.

Fig. 14. Cyst of external cartilage.

Figs. 15 and 15a. Loss of substance of the medial cartilage.

Fig. 16. Loss of substance of medial cartilage with a central "bucket handle" visible.

Fig. 17 and 17a. Irregularity of the surface of the medial meniscus.

Fig. 18. A fine linear tear in the substance of the cartilage.

Fig. 19. Displaced tag of cartilage visible and palpable between the attachment of the cartilage and the tibial plateau. A discoid cartilage not well shown.

Fig. 20. Fig. 20a.

Fig. 20. Rupture of medial collateral ligament showing escape of air round both upper and lower attachment.

Fig. 20a. Rupture of the medial collateral ligament, showing escape of air round its lower attachment.

insertion, as in the lateral cartilage, indicating cyst formation; (5) increase in distance between meniscus and articular cartilages peripherally, indicating ligamentous rupture (Fig. 20).

Air arthrography, by throwing up the shadows of the normally invisible cartilaginous layer on the condyles, makes possible the diagnosis of cartilaginous damage with which no

bony damage is associated (Fig. 12). This may be of value in early traumatic arthritis, and would produce a more convincing picture of the early stages of osteochondritis dissecans.

A few cases of rupture of the collateral ligaments of the knee have been arthrographed; information of some value as to the site of rupture of the ligament and the question of associated cartilage damage may be obtained. The surgeon who considers operation advisable in those cases in which the rupture is severe and permits more than slight opening of the joint, will gain considerable information as to the level of the rupture (which may be at the tibial attachment, the femoral attachment, opposite the joint line, or scattered through different layers at different levels) and so be able to center his incision more accurately.

Sufficient work has not yet been done to obtain the full roentgenological picture in the various types of rupture, but we believe this has interesting possibilities.

In intra-articular fractures, the method has not been used owing to the danger of air-embolism when cortical bone is opened up.

CASES IN WHICH AIR ARTHROGRAPHY IS UNLIKELY TO BE OF VALUE

As air arthrography only shows the shadow of the cartilage, detachments of the anterior and posterior horns in which the shape of the cartilage remains the same may be overlooked. These conditions are, however, rare, and the so called "hypermobile cartilage" is a lesion which it is difficult to prove scientifically, and which must be carefully considered, as it proves such an easy refuge for the careless surgeon. One case in our series had a detached anterior horn, held in position by the soft tissues, which was not diagnosed, together with a hypertrophic fatty pad.

Hypertrophic fatty pads are also impossible to diagnose roentgenologically, but a normal cartilage, shown by air arthrography, together with the characteristic story of giving without locking, click, or severe reaction, may assist in a preoperative diagnosis. The knowledge that the posterior half of the cartilage is normal is also of value in giving the surgeon confidence in a decision to leave the cartilage behind when no cartilage lesion is found at operation, and there is some doubt whether the fatty pad lesion is the cause of the trouble.

Very fine "bucket handle" tears may be difficult to visualize, but we have demonstrated lesions where the "bucket handle" was no more than 1/8 inch thick. Small tags have also been shown (Fig. 10), but it is admitted that their successful demonstration depends, to some extent, on their position and it would be possible to overlook them. We have shown that the transverse tear, more often operative than traumatic, may be demonstrated.

RESULTS

The object of this article has been to prove the ease with which satisfactory views of the menisci can be obtained by arthrography, and particularly with the technique described; and their value in diagnosis. The accurate relationship of the method to diagnosis, from a statistical viewpoint, is, however, very hard to prove, and with the limited number of cases available to us, can only lead us to very general conclusions. It is manifestly impossible to submit all negative findings to operation; it is in the negative cases that the possibility of roentgenological error remains unchecked.

RESULTS IN 75 CASES ARTHROGRAPHED

Ruptured medial collateral ligaments	3
Cysts of the external cartilage, with tears	3
Clinically and roentgenologically torn, refused operation	3
Clinically torn, roentgenologically confirmed, operatively torn	35
Clinically doubtful, roentgenologically proved, operatively torn	5
Clinically torn, roentgenologically normal, operatively torn	3
Clinically doubtful, roentgenologically negative, operatively normal	2
Clinically doubtful, roentgenologically negative, operatively torn	2
Clinically doubtful, roentgenologically negative, hypertrophic fatty pads	2
Clinically doubtful, roentgenologically negative, returned to unit	17

Thus, in 44 out of 49 cases operated upon, the roentgenological findings were confirmed operatively. In two of these, a negative arthrography was confirmed by the discovery of a normal cartilage, and the presence of a degenerative arthritis. These 2 cases occurred in the early stages of the investigation, when due weight was not given to the roentgenolog-

ical findings, which in these cases would have enabled one to avoid an undesirable operation. In 2 other cases the clinical findings were considered to justify operation, in spite of a negative arthrography. In both cases, a normal cartilage was found, and a hypertrophic fatty pad was apparently the cause of the symptoms. One of these was cured by the excision of the fatty pad alone, the knowledge that the cartilage was normal roentgenologically giving us confidence in leaving the cartilage in place.

Roentgenological errors occurred in 5 cases. In 2, very small anterior tears were found at operation, though the arthrograph was regarded as normal. In 1 later case, a posterior third tear of a meniscus (lateral) was found. In the remaining 2 cases, tears were diagnosed, and, at operation, nothing but a hypertrophic fatty pad was found. These 2 cases again occurred early in the series, when our technique and experience were not developed. In the later cases, our accuracy of roentgenological diagnosis became almost complete.

Every surgeon removing a series of cartilages will admit to some degree of inaccuracy of diagnosis. In our case, this was 8 per cent when unassisted by arthrography. Some of these cases made a clinical recovery, which may be accounted for by a hypermobile cartilage, or some other unappreciated factor. It is quite clear that if surgery were limited to roentgenologically positive cases, one hundred per cent accuracy could be otained, but, owing to an occasional failure of the method to show a small tear, or a hypertrophic fatty pad, this is not possible. After experience of arthrography, we increased the accuracy of diagnosis so that in the 49 cases in which operation was done, only 2 normal cartilages were removed, and both errors would have been avoided if the roentgenograms had been believed, while in the last 39 cases, 100 per cent accuracy has been achieved.

Interesting points raised by arthrography have been:

1. The ability to diagnose an early doubtful lesion without waiting for a confirmatory recurrence of trouble, so often recommended as the best procedure. We believe that where a definite "bucket handle" lesion, or posterior third tear is shown, immediate removal of the cartilage is justifiable, and thus completes patient's treatment in one stay in the hospital.

2. The frequency with which tears are present in association with cysts of the lateral cartilage has been well shown by the method.

3. A surgeon is given confidence to leave a cartilage in position when exploring a knee for a doubtful lesion, if he discovers a hypertrophic fatty pad which may reasonably be responsible for the symptoms.

4. The increased accuracy of diagnosis of lesions of the fatty pad when the cartilage can be proved normal.

It is, we think, safe to say that air arthrography is a simple procedure, devoid of risk, when correctly carried out, and that it is a valuable ancillary method of investigation, increasing the accuracy of preoperative diagnosis very considerably, and capable of raising it to one hundred per cent correct. Practiced as a routine, it provided that background of experience in the method, so necessary in the interpretation of difficult cases. It is of particular value in: (1) cases in which no adequate history is available; (2) cases in which the clinical findings are inconclusive, both as to site of the lesion, or its actual presence; (3) cases in which a double lesion is suspected, either a double tear, or a cyst and tear; (4) cases in which ligamentous laxity might account for the symptoms, and it is required to prove or disprove associated cartilage damage.

SUMMARY

1. A new technique for air arthrography of the knee is described.

2. The appearances of the normal lateral and medial cartilages are described.

3. The findings in cases of abnormal cartilages are detailed.

4. A summary of the results in 75 cases is given, with the clinical conclusions.

5. The accuracy of preoperative diagnosis is considerably increased, and 100 per cent accuracy can be achieved if only roentgenologically positive cases are submitted to operation. As we believe the method incapable of demonstrating lesions other than tears and damage to condylar cartilage, a few roentgenologically negative cases must be submitted to operation to introduce a possibility of error.

TRAUMATIZED MUSCLE TISSUE AS A FACTOR IN THE PRODUCTION OF SHOCK

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THE physiological and the pharmacological action of extracts of fresh tissue and the products of tissue decomposition has been studied for over half a century, but the part that these extracts play in shock resulting from trauma is still the object of much controversy. The conflict of opinion concerns the possibility of a systemic reaction resulting from toxic substances liberated at the site of injury.

Those supporting the theory that shock resulting from traumatized tissue is due solely to the local loss of fluid have denied the possible absorption from injured tissue (6, 8, 17, 18, 19, 20, 21). However, we now have sufficient evidence to prove that absorption from traumatized areas does occur (5, 7, 15, 16). Also the sequence of events which occurs in the "crush syndrome" demonstrates the absorption from crushed muscle tissue.

Granting that absorption from traumatized tissue does occur, are the products of tissue disintegration sufficiently toxic to contribute to the production of shock? The confusion which has resulted from the numerous investigations of this problem is apparently due to the failure to distinguish the difference in the action of the three types of tissue extract: (1) fresh tissue extract, (2) autolyzed tissue extract, and (3) tissue extracts containing bacterial metabolites. In our experimental study we have determined blood pressure response to the use of the three types of tissue extracts.

All the records in these experiments were obtained from dogs varying in weight from 10 to 20 kilograms. They were anesthetized with sodium pentobarbital (nembutal), approximately .03 gram per kilogram body weight, injected intravenously, and additional injections were made as necessary to maintain the anesthetic level. Blood pressure records were obtained by cannulating the right carotid artery and connecting the cannula to a mercury manometer by means of rubber tubing; the entire system was filled with sodium citrate solution. The respiratory movements were recorded by securing a stethograph drum to the chest.

From the Department of Physiology, The University of Oklahoma, School of Medicine.

FRESH TISSUE EXTRACT

Muscle tissue was obtained from dogs under nembutal anesthesia, and the tissue was removed from the thigh and gluteal regions. Care was taken to remove only muscle tissue, in so far as it was possible, and ordinary precautions were taken to prevent the introduction of outside contaminating factors. The muscle tissue was immediately cut into smaller pieces and ground in a meat chopper. One volume of physiological saline solution was added to one volume of the ground muscle tissue; the mixture was put into an Erlenmeyer flask, stoppered, and thoroughly mixed. The muscle-saline preparation then was kept at icebox temperature, approximately 5 degrees centigrade; subsequently it was filtered through several thicknesses of gauze and the filtrate was used for intravenous injections.

Figure 1 is a record of the result obtained from the injection of the saline extract of fresh muscle tissue. It will be observed that the intravenous injection of 1, 2, 4, and 8 cubic centimeters of such extract had little, if any, effect on the blood pressure. This result may be duplicated repeatedly provided the muscle extract is prepared so as to contain a minimum of fat and particulate matter, and the injections are given in graduated doses. These precautions will prevent the formation of emboli and thrombi (9).

AUTOLYZED TISSUE EXTRACT

The subject of tissue autolysis received renewed interest some years ago when it was demonstrated that a small piece of sectioned

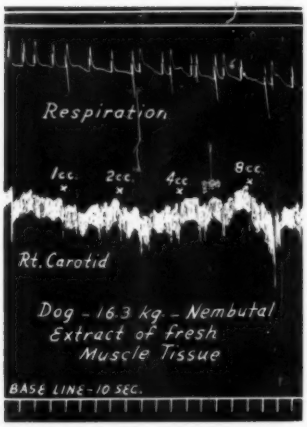

Fig. 1.

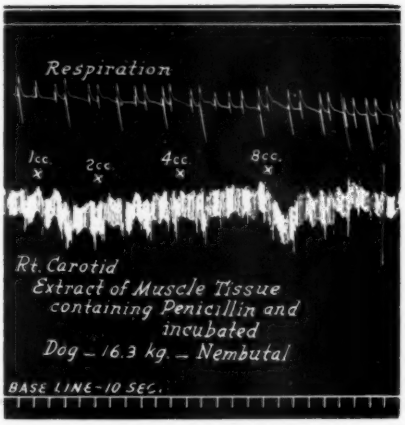

Fig. 2.

liver tissue free within the abdomen would cause death in 15 to 18 hours with the classical symptoms of shock, including hemoconcentration (2-4, 10-14). Since that time numerous investigators have studied the subject and more recently a comprehensive study of "Tissue Autolysis and Shock" (1) has appeared.

Figure 2 is presented to demonstrate the effect of the intravenous administration of saline extract of muscle tissue which has been subjected to conditions favoring autolysis. The ground muscle with an equal volume of physiological salt solution containing penicillin (more than 30 units per cubic centimeter) was incubated for 17 hours, filtered through gauze, and administered. The doses were the same as in Figure 1 and the effect was practically identical with that obtained from the fresh muscle extract. We have repeated these observations, allowing the material to incubate as long as 7 days, and none of the preparations proved to be markedly toxic. One is forced to conclude that either penicillin prevents the autolysis of muscle tissue or that autolysis of muscle tissue does not produce a toxin sufficiently abundant or active to induce shock.

TISSUE EXTRACTS CONTAINING BACTERIAL METABOLITES

The material for this part of the study was prepared by incubating the ground muscle which had been diluted with an equal volume

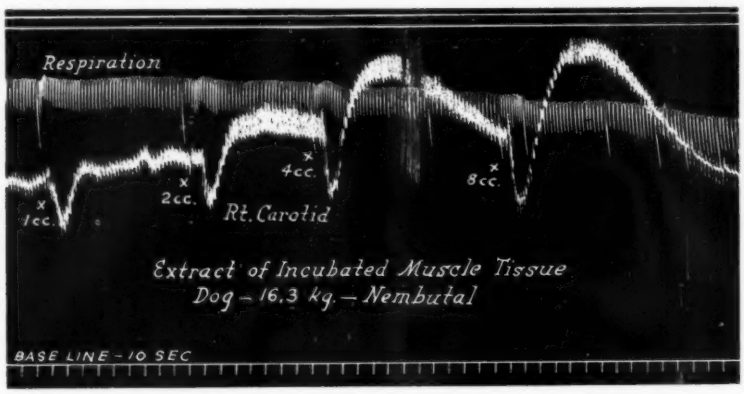

Fig. 3.

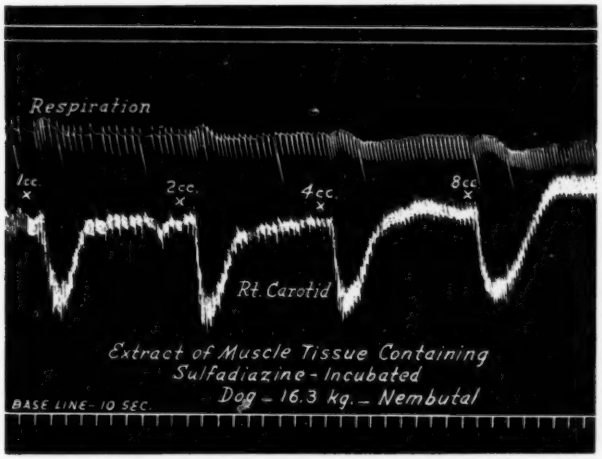

Fig. 4.

of physiological salt solution; no antiseptic was added. Figure 3 shows a record obtained during the administration of 1, 2, 4, and 8 cubic centimeters of the filtrate from a preparation which had been incubated for 17 hours. It will be observed that each injection produced a definite fall in blood pressure followed by a sharp rise, the rise often producing a blood pressure nearly twice that of the original. The blood pressure response is practically identical with that previously reported (12), when we used extracts of liver tissue which had been sectioned and left free within the abdomen for 15 to 18 hours. Comparing the blood pressure response recorded in Figure 2 with that recorded in Figure 3, one is impressed with the marked difference; the preparations used were incubated the same length of time and were identical except that penicillin was added to the former before incubating.

The following experiment was undertaken with the desire to determine the concentrations of penicillin necessary to prevent the formation of the toxic material which resulted from incubation. Graduated amounts of penicillin were added to the contents of 10 Erlenmeyer flasks each containing 50 grams of ground muscle and 50 cubic centimeters of physiological solution. The preparations were thoroughly mixed by shaking and then incubated for 48 hours. Table I is a record of (1) the amount of penicillin used, (2) the presence or absence of gas and odor, and (3) the blood pressure response to the injection of 4 cubic centimeters of the filtrate obtained from the contents of each flask.

TABLE I

Flask	Units of penicillin		Gas and odor	Blood pressure drop to 4 c.c. injection
	Total	Per c.c.		
1	50,000	500	Neither	None
2	25,000	250	Neither	None
3	12,500	125	Neither	None
4	6,250	62.5	Neither	None
5	3,125	31	Neither	None
6	1,560	16	Neither	None
7	780	8	Gas	16 mm.
8	390	4	Gas	16 mm.
9	195	2	Gas and odor	54 mm. (with sec. rise)
10	97	1	Gas and odor	Not injected

Desiring to test the effectiveness of sulfadiazine, we added an excessive amount to the muscle-saline mixture, 1 gram to 250 cubic centimeters, mixed thoroughly, and incubated for 17 hours. Figure 4 demonstrates the effect of the intravenous injection of 1, 2, 4, and 8 cubic centimeters of the filtrate. It will be noted that the amount of blood pressure reduction resulting from each injection was es-

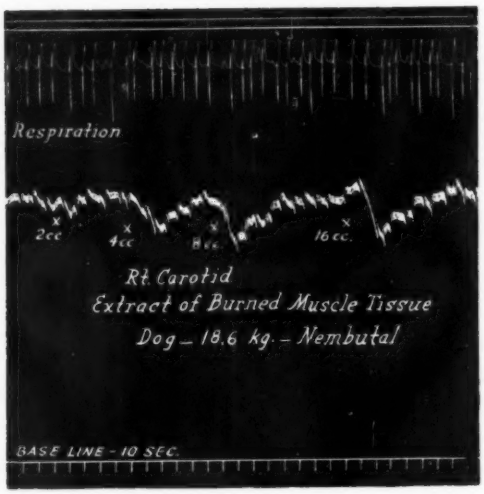

Fig. 5.

sentially the same, approximately one-half of the original pressure, regardless of the amount of injected material. No secondary rise in blood pressure occurred as observed in Figure 3.

BURNED TISSUE EXTRACT

A weighed amount of ground dog muscle was placed in a dry, clean (grease free) frying pan, and heated. The degree of heat and the length of time were varied depending upon the degree of burning desired. All degrees of burning were studied, from cooking until the pink color disappeared from the center of the mass to charring the entire muscle tissue. The burned tissue was placed in an Erlenmeyer flask and treated with a volume of physiological salt solution equal to the original muscle mass. It was then shaken thoroughly and kept at icebox temperature until used, at which time it was filtered, and the filtrate injected intravenously.

The intravenous administration of the filtrate obtained from the saline extract of burned muscle tissue usually produced little if any change in blood pressure. Figure 5 is a record obtained during the injection of 2, 4, 8, and 16 cubic centimeters of such a filtrate. The dose given is double that which was used in the previous records and the response is not marked.

CONCLUSIONS

1. Extracts of fresh muscle tissue, administered intravenously, produced little if any change in blood pressure.

2. The use of the filtrate obtained from ground muscle incubated with penicillin also produced little change in blood pressure.

3. The filtrate of muscle tissue incubated with sulfadiazine produced a marked lowering of blood pressure, the drop being equal to approximately one-half of the original pressure.

4. Extracts of muscle tissue incubated without the presence of any antiseptic produced a fall in blood pressure followed by a secondary rise. The increased blood pressure was often double the original pressure.

5. The blood pressure response to incubated muscle tissue, without an antiseptic, is practically identical with that we have previously reported when using extracts of liver tissue sectioned and left free within the abdomen.

6. Administration of the saline solution extract of burned fresh muscle tissue produced little if any change in blood pressure.

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AN IMPROVED PERMANENT COLOSTOMY

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THE prospective owner of a permanent colostomy must view his future with awe. Nevertheless, the early repugnance with which patients regard their disability is usually replaced by a sense of the inevitable. The possible cure of a foul disease seems to lend them support to maintain a tolerable existence.

Apart from the infrequent surgical complications of stenosis and prolapse, however expert may have been the performance of the operation, there remains the imperfection that the colostomy, in regard to fluid loss and gas, is uncontrollable, even artificially. Rubber bags, obturators of various kinds, complicated, and therefore cumbersome, colostomy cups, have all had their day and have been found wanting in many ways. The mucous membrane of the colon will not withstand plugging for any length of time, and so far as we are aware, any attempt to control the efflux of feces in this way has failed. It has been established beyond question that the best fashioned colostomy is a severe domestic and social embarrassment.

It occurred to one of us (J.O.S.) while observing the other (B.K.R.) constructing buried inverted skin tubes for a cineplastic forearm amputation, that a similar type of skin tube might be made as the terminal segment of a colostomy, with some prospect of the successful use of a mechanical plug.

In adapting this suggestion, it was ultimately decided that the appropriate surgical procedure would best be designed and executed in two stages. This for two reasons:

1. To avoid stricture formation. Areas in relation to the anastomosis of skin tube with bowel cannot be left prone to secondary intention healing and scar formation. This is more easily achieved if the skin tube is made and healed as a primary procedure before any attempt at mucocutaneous anastomosis. Only in this way can new suture lines meeting in divers planes and directions be avoided. Such are always vulnerable points, even in favorable circumstances, but in association with fecal contamination, rarely could effective primary healing be expected.

2. To avoid increase of operation risk. Patients mainly of the upper age group, after a perineoabdominal operation for excision of the rectum are generally unfit to withstand the extra time of a tedious plastic operation. Moreover, patients in low ebb of vitality are poor subjects in which to embark on plastic procedures, which at least require a healthy peripheral circulation.

Using variations of common principles, our object was successfully accomplished by one of us (B.K.R.) in 3 cases with an evolution of method and success. Without expounding details which were tried and the difficulties encountered, the method used in the third case will now be described as a prototype operation in relation to Figure 1.

STAGE 1

Construction of a buried inverted skin tube. A rectangle of skin $ABA'B'$, approximately 2 by 4 inches is designed (Fig. 1a) on the lower left quadrant of the abdomen. The center of its upper and long side is at a point lateral to the rectal sheath where the bowel is to leave the abdomen. This skin area will line the tube. The ends only of the rectangle are raised as two separate flaps of skin and fat (Fig. 1b), each flap containing slightly less than one-third of the rectangular area. When each of these flaps is turned back on its attached base, the free ends are sutured together to make a skin-lined tube (Fig. 1c). Silk is used for this suturing. Separate inverted end-on mattress sutures are used at either end of the tube, and a continuous subcuticular mattress stitch along its length. The latter is anchored at either end to the single stitches and left long for identification purposes.

There now remains a raw surface corresponding to the area of the original rectangle

marked out. This surface is covered by a flap of appropriate dimensions transposed from the region *CDEF* on an oblique base *CD* (Fig. 1d). This is a "safe" flap. When transposed to the raw area (Fig. 1e), its center portion will overlie the outside of the skin tube. Its whole free margin is sutured to the defect. This means that the central parts of its long margins are sutured to the free skin circumference at each end of the skin tube. Interrupted stitches of fine silk are used for this purpose.

This completes the skin tube, but leaves a secondary defect in the left loin. In some subjects with a loose abdominal wall, after wide lateral undermining, it is possible to close the secondary defect by direct suture (Fig. 1f,*A*). In others, it is better closed by a large rotation advancement flap (Fig. 1f, *B*). This flap serves a twofold purpose in distributing tension over a long suture line and transferring maximum tension to a remote region of relatively no importance.

STAGE 2

Anastomosis of the bowel end to the skin tube. Skin incisions *WXYZ* are made (Fig. 1g), including a ring incision around the proximal circumference of the skin tube. Turning back the flaps *WXY* and *WXZ* (Fig. 1h), the abdomen is now opened as through a muscle splitting incision. The free end of the bowel tied with a tape during the main abdominal operation is delivered through this wound. The peritoneum is closed around the bowel, leaving sufficient length for subcutaneous anastomosis to the skin tube. After trimming, the bowel end is anastomosed to the skin lining of the tube (Fig. 1i), with many interrupted catgut stitches, including some inverted mattress stitches. The skin wound is now closed, so that the flaps *WXY* and *WXZ* now lie anterior to the bowel, the line *XY* and the line *XZ* are outside the line of mucocutaneous anastomosis and *X* meets *X'* (Fig. 1j). The final scars of surface suture lines are either as marked in Figure 1k or 1l, according to the manner in which the secondary defect was closed in Stage 1.

SUMMARIES OF CASE REPORTS

CASE 1. (Lt. Col. Smith's patient.) Bdr. J. H., aged 35 years, had a fungating carcinoma of the rectum with papillomatosis. His operation program was as follows:

Operation 1 was performed May 15, 1944 under local anesthetic. A buried inverted skin tube was made (Stage 1). Primary healing followed.

Operation 2 was performed June 16, 1944, under general anesthesia. Excision of rectum and lower sigmoid were done by the combined approach (Lt. Col. Smith and Major Ackland). Bowel skin tube anastomosis was made (Stage 2). The mistake was made of not joining the iliac wound to the marginal incision around the skin tube opening. The bowel between the iliac wound and mucocutaneous anastomosis was not buried, and there was a bridge of abdominal skin beneath the exposed bowel. At this stage there was no colostomy opening other than by the skin tube, but 2 days later the bowel was opened to function as a colostomy on its exposed portion above the skin tube anastomosis. After this, the mucocutaneous anastomosis became detached.

Operation 3 was performed August 2, 1944 under general anesthesia. Reanastomosis of bowel to skin tube was done. This time the anastomosis was buried by raising the bridge of skin between the iliac wound and skin tube and by laying the bowel beneath it. This was distal to the now functioning colostomy. This anastomosis remained clean and healed.

Operation 4 was performed August 21, 1944, under general anesthetic. Closure of colostomy and burial of exposed bowel were done. A large Estlander type skin flap was used. There was a good deal of pain and distention following this operation, but after a purgative, the bowel discharged freely through the skin tube. Three small fistulas then developed in the suture line proximal to the skin tube. Two of these healed rapidly and spontaneously, the third persisted with a slight leak for some weeks, when it, too, eventually closed.

On November 10, 1944, all was well healed, and he commenced to plug intermittently the skin tube with dental rolls. An acrylic plug was later supplied him.

On July 10, 1946, when last reviewed, the skin tube colostomy was clean and easily manageable. His bowel opens in the morning, after which he plugs the skin tube with an acrylic plug retained by a belt. He complains of occasional wind and distention. A finger could be easily passed up the skin tube into the bowel without any suggestion of stenosis.

Photographs of this patient are shown in Figure 2a.

CASE 2. (Lt. Col. Renou's patient.) Cpl. C.F.N., aged 41 years, had an ulcerating carcinoma of the rectum. His operative program was carried out as follows:

Operation 1 was done August 8, 1945, under local anesthesia. Buried inverted skin tube was made (Stage 1). Primary healing followed.

Operation 2 was performed August 23, 1945, under general anesthesia. Combined abdominoperineal excision of the rectum (Lt. Col. Renou and Major

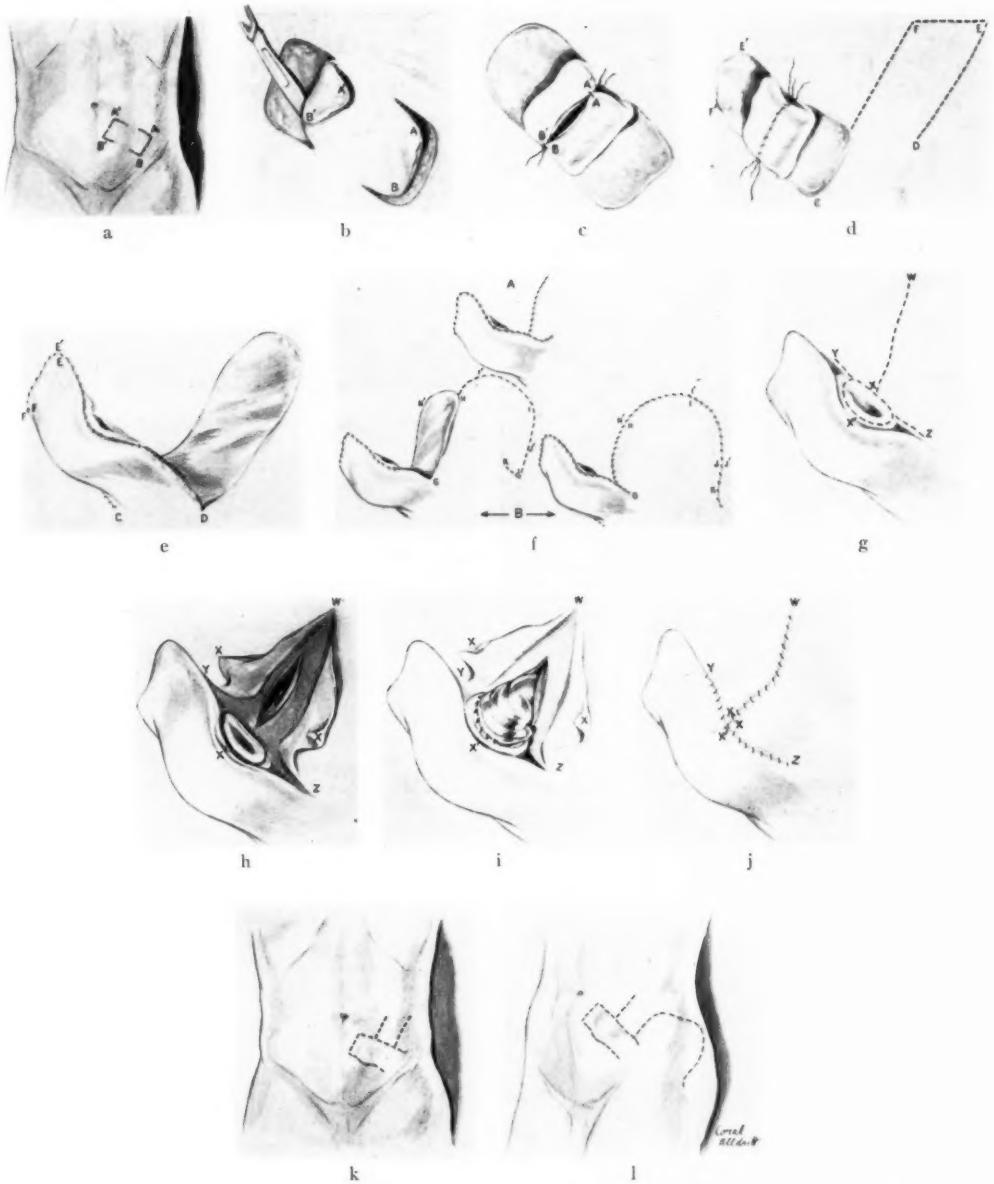
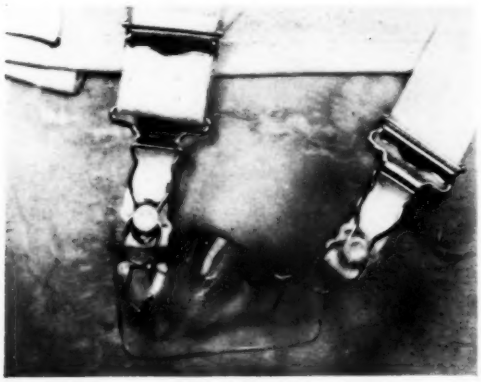


Fig. 1. Prototype operation. Stage 1: a, Rectangle of skin designed. b, Ends of rectangle raised as two separate flaps. c, Flaps sutured together. d, Flap designed to cover raw area left by making of tube. e, Transposition of flap. f, Methods of closure of secondary defect. Stage 2: g, Skin incisions made for anstomosis of bowel end to skin tube. h, Flaps turned back from these incisions. i, Bowel end anastomosed to skin lining of the tube. j, Closure of wounds. k, l, Final scars of suture lines, according to method of closing the secondary defect.

a



b

a

c

Fig. 2. Methods of plugging. a, Case 1. b, Case 2. c, Case 3.

Mackay) was performed. Buried anastomosis was made of bowel to skin tube. Proximal to this the bowel was left uncovered by skin and was opened.

Operation 3 was done, September 24, 1945, under local anesthesia. Closure of a fistula was made at site of partial breakdown of mucocutaneous anastomosis. This, too, subsequently broke down. It was difficult to prevent feces getting into the bowel distal to the colostomy opening, despite many types of dressing and packing.

Operation 4 was performed October 13, 1945, under local anesthesia. Transverse colostomy.

Operation 5 was performed November 3, 1945 under local anesthesia. Closure of recurrent fecal fistula in mucocutaneous anastomosis. Closure of distal colostomy. After this all wounds remained healed.

Operation 6 was performed November 21, 1945, under general anesthesia. Closure of transverse colostomy was done. On December 3, 1945, he started to use a plug in the skin tube.

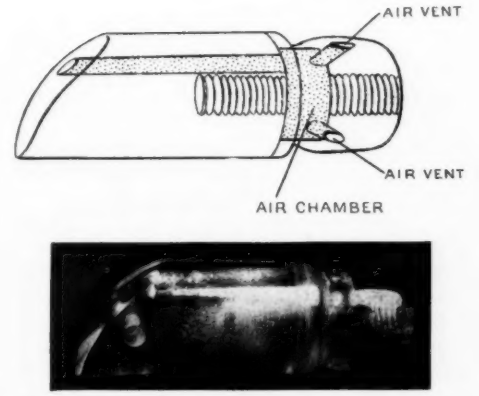
On July 1, 1946, when last reviewed, colostomy was clean and easy to manage. He is in the habit of inserting a plug after his bowel action in the morning. He has good bowel habit and control and gets a sensation of fullness when the plug is *in situ* with the bowel full. He is using a plug made with a wind vent as in Figure 3.

This case is illustrated in Figure 2b.

Case 3. (Major Mackay's patient.) Pte. J.P.H., aged 54 years, had a carcinoma of the rectum. His operative program was as follows:

Operation 1 was performed September 26, 1945, under general anesthesia. Laparotomy and transverse colostomy were carried out. Construction of buried skin tube was made (Stage 1). Four days later the transverse colostomy was opened. The main operation was postponed for some time because of a cardiac condition indicating special treatment.

Operation 2 was performed December 3, 1945, under spinal and gas anesthesia. Abdominoperineal excision of rectum was done (Lt. Col. Renou and



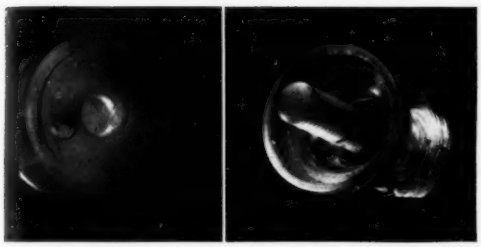


Fig. 3. Acrylic plug with wind vent. Model as used in Case 2.

Fig. 4. External appearance of the skin tube colostomy of over 2 years' standing. The photograph shows the skin in good condition. There has never been any skin irritation or breakdown.

Major Mackay). Distal free end of sigmoid anastomosed to proximal end of skin tube and buried subcutaneously as described in stage 2 of prototype operation. This healed *per primam*.

Operation 3 was January 31, 1946, under local anesthesia. Closure of transverse colostomy, extraperineal, was done.

On February 1, 1946, the skin tube colostomy commenced to function and has continued satisfactorily since. An acrylic plug was made and fitted which at first caused some difficulty because of the persistently fluid nature of his feces.

On June 1, 1946, patient was fitted with a new type of plug which he was managing well.

This patient (Fig. 2c.) subsequently developed recurrence of growth in the perineal wound. He became bedridden and though he abandoned use of the plug, the skin tube colostomy remained clean and functioned well, despite repeated bouts of diarrhea.

In Cases 1 and 2 we failed to achieve primary healing in the anastomosis of bowel to the skin tube. There was breakdown with fecal fistulas at the junction line. In the first case, it is still to be wondered that spontaneous healing—though delayed—did occur. In the second case, the fistulas were only closed after a secondary transverse colostomy was done to break the fecal flow. In the third case, where preliminary colostomy had been done so that the original anastomosis at the end of the major operation for rectal excision was done on a defunctioned bowel, the optimum of primary healing was obtained.

On this experience, it is our considered opinion that the anastomosing procedure is best attempted only on a defunctioned bowel, despite the disadvantage of the extra stages it involves. The best initial procedure is a limited abdominal exploration, with transverse colostomy. It is not our purpose at this juncture to argue whether formal exploration should be dispensed with or not; but rather to state that a transverse colostomy is the essential preliminary to an efficient mucocutaneous anastomosis later.

In relation to an elective operation for rectal excision as for cancer, we consider the operative program to achieve a skin tube colostomy in the safest and most satisfactory way, should be in three stages.

Operation 1: (a) laparotomy, (b) construction of buried skin tube (Stage 1), (c) transverse colostomy.

Operation 2: (a) abdominoperineal excision of rectum, (b) buried anastomosis of terminal bowel end to skin tube (Stage 2).

Operation 3: closure of transverse colostomy.

THE PLUG

The main purpose of the operation implies the use of an efficient plug to render the colostomy controllable. At first dental rolls of packed wool were used. These were too easily and rapidly forced out, and it seemed that some retention arrangement was necessary. Various types of rigid acrylic plug and retention arrangements have been made and tried, including one to allow wind escape (Fig. 3). The patient in Case 2 uses this effectively, but finds it difficult to keep clean. Some soft material (such as polyvinyl) or the use of an inflatable cuff with some attempt to shape the skin tube may be the indication.

Many more cases require to be done before any definite conclusions can be made of the value of such a colostomy, including further work and elaboration on the best medium, means, and routine of plugging the skin tube.

We regard this only as a preliminary report, warranted by the establishment of a new principle in colostomy which we have demonstrated as a practical proposition. We do not believe that the principle should be applied to all cases of colostomy. It appears desirable in such a patient as our first case, a man 35 years old with the prospect of many years of life before him but condemned to an artificial anus. Our longest standing case of over 2 years has shown that the skin tolerates both feces and plugging with no untoward effect (Fig. 4). When the colostomy is plugged, a sensation of local fullness in the region is experienced when the bowel is full. The skin tube colostomy can be easily kept clean and is altogether a more controllable and more manageable proposition than the standard types of colostomy.

With appropriate teamwork, the necessary procedures can be carried out without added risk to the subject and with no undue upset of the main plan and procedures necessary to operation.

AN EVALUATION OF ABDOMINAL WOUND CLOSURE

Steel Wire Layer Closure Compared with Catgut-Silk Layer Closure, Early and Late Results

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CONSIDERABLE controversy still exists among surgeons in the choice of suture material and the method of closure of abdominal wounds. We wish to present a method of abdominal wound closure which, though not new, has so decreased our early and late wound complications as to bear emphasis.

Two hundred twenty celiotomy wounds were studied; 110 of these were closed with a catgut-silk combination, and 110 were closed with a steel wire-silk combination.

The patients studied present a rather severe test of wound closure. All belong to an economically indigent group derived from rural areas. One hundred and fifty-nine patients had some type of abdominal cancer. The average age of the entire group was 58 years. In this hospital approximately 45 per cent of the patients upon whom major surgery is performed have a total serum protein on admission below 6.5 grams per cent, and about 90 per cent show a decline in their serum protein postoperatively despite vigorous protein therapy (10). A high incidence of marked weight loss (9) and frequently a moderate to severe anemia on admission are common findings. Because of these adverse factors it is mandatory that every effort possible be made to prevent the development of postoperative complications. As has lately been re-emphasized (8), a high degree of control of all possible factors in surgery on such patients is essential if success is to be attained with regularity. The use of steel wire in closing abdominal wounds as described later has provided an additional safety factor. A careful follow-up of all patients makes it possible not only to observe the early but the late wound complications.

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The suture materials used in this study have included catgut, silk, cotton, and steel wire. Large has shown a decreasing tolerance to suture material in the following order: fine stainless steel wire, cotton, silk, plastigut, nylon, and catgut.

The method of closure for those patients in whom catgut and silk were used was as follows: The peritoneum was closed with a continuous No. 1 chromic catgut stitch. The other layers, fascia, subcutaneous tissue and skin, were approximated with interrupted silk sutures. Approximately one-third of these wounds (35 per cent) were reinforced with silkworm gut stay sutures through the skin, subcutaneous tissue, rectus muscle, and anterior rectus sheath.

The method of closure in the group in which steel wire and silk were employed is essentially the same as that used by Louis Snead and described by Jones. We have modified it inasmuch as we use interrupted fine silk or cotton to close the subcutaneous tissue and interrupted silk or cotton to approximate the skin. The wire used is an alloy steel wire (No. 28 or 30). We have noted that if a finer grade than No. 30 is used it has a tendency to cut the tissues. At present we prefer the heavier grade, No. 28. The alloy steel wire stitch goes through both layers of the rectus sheath, the intervening muscle, and the peritoneum. The stitch is then brought out through all of these layers on the opposite side of the wound and a second loop is taken to approximate the anterior fascial layer of the rectus sheath (Fig. 1). Recently we have noted that at times precise apposition of the peritoneum did not always result with this technique. Accordingly, we now incorporate a loop through the peritoneum and the rest of the stitch is taken as described (Fig. 2). Before placing the anterior fascial loop the stitch

Figs. 1 and 2. Method of closing abdominal wound.

is drawn snug, apposing the peritoneum. Deep bites of tissue are taken (1.5 to 2.5 cm.) on each side of the wound to add strength to the closure during the initial postoperative period and to provide more cushioning, and therefore less strangulation of the tissues. The stitch is drawn snug and a double square knot is then tied about 1 centimeter above the anterior fascial sheath. Approximation of the wound is all that is needed and when the suture is released it lies loosely in the tissues. A tightly drawn suture will cause wound edema or even ischemic necrosis. The later complication has not been observed at this hospital. After they are tied, the wires are cut flush with a hemostat placed just above the knot. The hemostat is then rotated, so that the cut ends of the wire are turned downward. This is particularly important in individuals with little subcutaneous fat, otherwise the sharp ends may impinge on the under surface of the skin and cause pain. This method of wound closure does not eliminate the necessity for careful asepsis and hemostasis. We believe it promotes gentleness in the handling of tissues, as one stitch approximates the peritoneum, rectus sheath, and muscle.

The complications encountered with these two methods of abdominal wound closure consisted of: 37 (3.36 per cent) in the catgut-silk group, and 8 (0.07 per cent) in the wire-silk group. Five minor wound infections occurred in the catgut-silk group and 6 in the wire-silk group. Four major infections occurred in the former group and none in the latter group. Of the wounds which became infected in the catgut-silk group, 3 were classified as potentially contaminated at the time of operation. In the wire-silk group 1 was classified as potentially contaminated at operation.

Dehiscences are divided into major and minor, the former term being used when the wound separated to the peritoneum from without, or to the skin from within; the latter when only skin and subcutaneous tissue separated. There were 2 minor and 5 major dehiscences in the catgut-silk group, and none in the wire-silk group.

The term eventration is used only when there was actual protrusion of abdominal viscera through the wound. The incidence of eventrations in the 158 cancer patients in both groups was 1.8 per cent. This is in keeping with the findings of others. Glenn and Moore reported an incidence of eventration of 1.39 per cent in patients with malignant disease and of 0.51 per cent in patients without malignant disease. The 3 eventrations occurring in this study were in the catgut-silk group, and as is seen in Table I they are all in patients with cancer. One of the patients in whom evisceration occurred subsequently died in the hospital of peritonitis. An added initial strain was placed on the wound in most of the patients in the steel-wire group inasmuch as they were gotten up on the first or second postoperative day. However, in spite of this there were no dehiscences or eventrations. In the nonmalignant conditions also fewer complications occurred in the steel wire-silk group.

A study of the late results shows 12 postoperative incisional hernias in the catgut-silk group and none in the wire-silk group. In the catgut-silk group there were 36, and in the wire-silk group 35, patients who had cancer of the rectum or the lower sigmoid, requiring permanent colostomies. In the catgut-silk group the permanent colostomy was customarily brought out through an accessory muscle splitting incision in the left lower quadrant.

In the wire-silk group the colostomy was brought out through the original left rectus muscle splitting incision. In the 36 patients in the catgut-silk group, 11 developed hernias about the colostomy. In the 35 patients in the wire-silk group, 3 developed hernias about the colostomy. Two of these were loop colostomies. Because of the subsequent atrophy of the defunctionated distal limb, a disproportion not infrequently develops between the wound opening, as originally made, and the bowel. Accordingly, it is not uncommon to find late herniation about loop colostomies regardless of the type of wound closure. At the present time almost all colostomies, both permanent and temporary, are brought out through the rectus muscle splitting abdominal incision. The wounds have healed per primam, and in temporary colostomies the closures have been accomplished without difficulty or wound weakness.

One painful incision occurred in each group. The one in the catgut-silk group was not relieved by excision of the painful scar, and the one in the wire-silk group was not relieved by removal of the wire stitches. Both patients were considered to be hyperesthetic individuals in other respects.

There were 4 instances of sinus tract formation in the catgut-silk group as compared to 1 in the wire-silk group. Jones also observed a low incidence of sinus tract formation following the use of buried alloy steel wire.

In the presence of infection or gross soiling we feel that steel wire employed in the manner described is the suture material of choice. Since the above investigation was made we have had 1 patient who had a colostomy and developed postoperative intestinal obstruction. At the time of operation, after release of the obstruction, there was inadvertent spilling of fecal material from the colostomy into the abdominal wound. The wound was closed with steel wire as described previously. On the fourth postoperative day because of infection throughout the entire length of the subcutaneous layer down to the anterior layer of the rectus sheath, the wound had to be opened superficially and the steel wire sutures were exposed in the base of the wound. In spite of repeated contamination from the colostomy the wound rapidly healed with the application of wet dressings and with daily irrigations. The granulation tissue quickly covered the steel wires without the development of sinus tracts or incisional hernia.

TABLE I.—EARLY AND LATE ABDOMINAL WOUND COMPLICATIONS IN MALIGNANT CONDITIONS

	Group A Catgut-silk closure	Group B Steel wire silk closure
No. patients	72	86
Total complications	21	5
Wound infections		
Minor	4	4
Major	2	0
Dehiscence		
Minor	1	0
Major	4	0
Eventrations	3	0
Incisional hernia		
Infected wound	2	0
Noninfected wound	2	0
Painful wound	0	0
Sinus tracts	3	1
Serum pocket	0	0

DISCUSSION

A through-and-through closure (stay suture) of some nonabsorbable suture material has been generally accepted as the best method for closure of disrupted wounds (1, 2, 7). The value of careful approximation of fascial layers has been stressed by Howes and Norris. The technique described here employing stainless steel wire has the combined advantages of a layer closure because of the small loops which appose the peritoneum and fascia, and of a stay suture because of the through-and-through loop with its deep bites of tissue. This method of closure eliminates the need for conventional stay sutures.

It has frequently been noted that the interstices in multifilament suture material act as niduses for the growth of bacteria in contaminated or questionably clean wounds, and in the presence of infection may result in sinus tract formation. This possibility is eliminated when steel wire is used.

We believe that the greater success of steel wire abdominal wound closure as it has been described can be attributed to the following factors:

1. The greater tensile strength produces a stronger wound in the immediate postoperative period before wound repair has occurred.

2. Less trauma is necessary and tissue strangulation may more easily be avoided in placing sutures in such a manner, than is possible with the usual types of layer closure.

3. This, combined with the fact that there is less tissue reaction to the alloy steel, promotes increased resistance to infection and more rapid wound healing.

SUMMARY AND CONCLUSIONS

1. A comparison between 110 abdominal wounds closed with catgut-silk is made with a similar number closed with alloy steel wire.

2. The overall incidence of wound complications in the catgut-silk group was 37 (3.36 per cent), and in the steel wire group, 8 (0.07 per cent).

3. Alloy steel wire was well tolerated by the tissues. It can be used in the presence of infection with little fear of sinus tract formation.

4. Dehiscences or eventrations occurred in 10 wounds (9 per cent) in the catgut-silk group. No such accident occurred in the steel wire group.

5. Postoperative incisional hernias were reduced from 12 (11 per cent) in the catgut-silk group to none in the steel wire group.

6. We believe that the method described for using alloy steel wire produces less trauma, results in maximum tensile strength during the early postoperative period when it is most needed and combines the advantages of a layer closure with the advantages of a stay suture closure.

7. The use of alloy steel wire has provided an added safety factor in the surgical management of the poor risk patient.

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INTESTINAL LIPODYSTROPHY (WHIPPLE'S DISEASE)

Preliminary Report of Three Cases in an Early Stage of the Disease

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SINCE Whipple first described a case of "intestinal lipodystrophy" in 1907, 13 additional cases have been reported in the literature (1–3, 5, 6, 9–14). Recently, 3 patients who we believe had the disease in an early stage came under our care. The condition of all was suspected on the basis of the gross observations made at operation, and the suspicion was confirmed by the results of biopsy. In addition to the fact that these 3 patients presumably had a rarely described disease, they are of interest because the condition was diagnosed relatively early and because an opportunity became available for study of the disease as it progresses.

REPORT OF CASES

CASE 1. A man, 65 years old, was admitted to the Mayo Clinic on December 26, 1945, with a history of change in bowel habits of 3 months' duration and pain of 2 months' duration in the lower part of the abdomen. Otherwise, the medical history revealed only an episode of soreness, stiffness, and swelling of several joints for a period of 1 week when the patient was 16 years old. Three months before admission of the patient, he had begun to have two to four small, hard, lumpy stools daily, in contrast to one normal stool daily, previous to that time. One month later an intermittent, cramplike type of pain in the lower part of the abdomen had developed. These symptoms had continued unremittingly. Four days before his admission the patient had experienced rather severe, persistent low backache. At no time had there been any symptoms referable to the upper part of the gastrointestinal tract. Results of a general systemic inquiry were negative except for the information that about 30 pounds (about 14 kgm.) had been lost during the preceding year.

Physical examination revealed only an indefinite nontender mass in the upper and middle parts of the abdomen. The essential laboratory observations are summarized in Table I. Results of roentgenologic examination of the stomach, small intestine, and colon were negative.

Because of the presence of an abdominal mass and because loss of weight appeared to be progressive, the patient underwent operation on January 4, 1946. The tissues of the mesentery of the small intestine were found to be greatly swollen and thickened. They presented a dirty, creamy color suggestive of that of dilated lacteal vessels. There were no firm tumors. On palpation the mass in the abdomen felt leathery. The tissues most involved were those at the attachment of the mesentery to the posterior abdominal wall. There was some extension of the process into the mesentery toward the small bowel. The wall of the small bowel was normal. The pancreas was normal to inspection and palpation. There was no evidence that any tumor was compressing the thoracic duct. Results of further exploration of the abdomen were negative. A specimen of tissue near the base of the mesentery and another specimen from a more distal portion of mesentery were taken for histopathologic study.

Sections of the tissues in question proved to contain intracellular and extracellular fat, numerous mononuclear foam cells, marked necrosis of fat with a cellular infiltration consisting mainly of lymphocytes but also including occasional polymorphonuclear and eosinophilic cells. In several places fibrosis of varying degree was demonstrated.. There was only an occasional foreign-body giant cell to be seen (Fig. 1, a).

The postoperative course of this patient was uneventful. As a result of the observations made at operation, additional studies relating to digestion and absorption were carried out (Table I). A special diet, in which 101.6 grams of fat and 117.5 grams of protein were to be ingested daily, was prescribed. The average daily content of fats and nitrogen in the feces was within normal limits. The blood fats were studied. In general, the values for blood fats were found to be low normal or subnormal. The values for blood calcium, phosphorus and serum protein were normal or approximately so. The basal metabolic rate and the values for gastric acids were reported as normal. The patient continued to have mild leucocytosis and to lose weight, in spite of the fact that he was eating food that provided 2,400 calories daily. Results of the Exton and Rose glucose tolerance test and vitamin A tolerance tests were normal.

During the patient's postoperative course in the hospital a few small discrete lymph nodes were felt in each groin and in the left axilla. However, specimens for biopsy were not taken from any of these three locations. It was decided to watch for any further enlargement.

From the Divisions of Surgery and of Medicine, Mayo Clinic, and the Division of Surgery, Mayo Foundation.

TABLE I.—INTESTINAL LIPODYSTROPHY: COLLECTED LABORATORY DATA IN CASE 1

	Dec. 1945, day		Jan. 1946, day					
Value for, or results of	26	29	5	9	10	14	18	28
Leucocytes, per cu. mm. of blood	15,100	15,100	13,900	10,500				19,100
Hemoglobin, gm., 100 c.c. of blood	13.8		12.7					13.2
Sedimentation rate (Westergren), mm. per hr.	46	50	50					
Urea, mgm., 100 c.c. of blood			22	34				
CO_2 combining power, vols., 100 c.c. of plasma			53.2	50.4				
Chlorides, mgm., 100 c.c. of plasma			505	015				
Cholesterol, mgm., 100 c.c. of plasma				123	97		117	137
Cholesterol esters, mgm., 100 c.c. of plasma				47	48		64	84
Fatty acids, mgm., 100 c.c. of plasma				189	234		190	244
Lecithin, mgm., 100 c.c. of plasma					184		155	209
Lipoids, total, mgm., 100 c.c. of plasma				322	331		307	381
Calcium, mgm., 100 c.c. of serum					8.2		9.9	9.9
Phosphorus, mgm., 100 c.c. of serum					3.5		3.9	3.6
Liver function (bromsulfalein test)				No retention				
Basal metabolic rate								+12
Bilirubin, mgm., 100 c.c. serum					Indirect 0.5			
Proteins, total, mgm., 100 c.c. serum A/G ratio					5.0 1.0:1		0.73 1.0:1	7.3 1.7:1
Gastric acids (free), units (Topfer) (total)						26 34		
Glucose tolerance test (Exton and Rose)							Normal	
Vitamin A tolerance test							Normal	Normal
Fats, stools (average daily value)							Normal	
Nitrogen, stools (average daily value)							Normal	

The patient received roentgenologic treatments on four successive days. They were administered over the abdomen. He was instructed to take one to two tablets of a choleretic agent (ketochol, a form of bile salts) after each meal. This treatment was based on the apparent success achieved with roentgen rays in Boeck's case and with bile salts therapy in Pearse's case.

CASE 2. A woman, 62 years old, was admitted to the clinic on February 8, 1946, complaining of an abdominal mass that had been found by her referring physician during a physical examination. The history revealed that the patient had had smallpox in 1921 and pyelitis in 1935 and 1943. A stone in the left ureter had been found in 1943. Surgical treatment carried out previously included appendectomy in 1916, hysterectomy and oophorectomy for carcinoma of the uterus in 1917, and cholecystectomy for gall stones in 1935. The patient had had hypertension subsequent to 1935; the blood pressure at systole usually was found to be around 200 millimeters of mercury.

In August, 1945, the patient had had an attack of distress in the upper part of the abdomen. The pain had extended to the shoulder blades and was relieved by vomiting. In December, 1945, she had had a similar attack and had applied heat locally for relief. She had burned her abdomen, and in the course of treatment her physician had felt an abdominal mass. A careful systemic inquiry revealed that she had had six episodes of diarrhea, each lasting a week, in the year prior to her admission to the clinic. At these times she had passed four to eight stools during the first 2 hours after breakfast. Sometimes nausea and vomiting, but not pain, had occurred. The diarrheic stool had consisted mainly of undigested food, and occasionally of mucus and frothy material. The patient believed that her stools had become bulkier during the period of the year prior to the time when we saw her.

On physical examination the patient was found to have a systolic blood pressure of 210 and a diastolic pressure of 100, expressed in millimeters of mercury. The pulse rate and temperature were normal. Abdominal examination revealed an ill-defined nontender mass which was situated at the level of the umbilicus.

The essential laboratory observations are included

in Table II. Results of roentgenograms taken of the colon and of the thorax were negative. The sedimentation rate of the blood was 16 millimeters in 1 hour (Westergren method).

On February 14, 1946, the patient was operated on by Dr. D. O. Ferris. In the surgical report it was said: "The mass was found to be in the mesentery of the small bowel. It arose from the root of the mesentery, and at the site was 2 to 3 inches in thickness and looked like fat necrosis. Interestingly, the lacteals of the small bowel were all dilated and were two to three times normal size, making definite white streaks across the small bowel." The other organs were reported as being normal. A specimen of tissue was taken for microscopic study (Fig. 1, b). The description of the specimen is exactly that given for the specimen concerned in the preceding case. *In both cases the absence of many giant cells and much fibrosis is believed to result from the fact that the condition itself was in a relatively early stage, meaning that had the process continued further, dilatation of lymph spaces and more fibrosis would have been observed.*

The condition of this patient was also studied postoperatively from the standpoint of possible abnormalities in intestinal absorption and in fat metabolism. The observations are summarized in Table II. All the results of laboratory studies were within normal limits. The patient was dismissed after being instructed in the taking of bile salts.

CASE 3. A woman, 58 years old, was first admitted to the clinic on December 31, 1928. At that time she was found to have a duodenal ulcer, hay fever, and mild arthritis of the left shoulder. She was again seen at the clinic on December 11, 1945. She had followed a medical regimen for the ulcer for about 15 years, with satisfactory results. Regression of the symptoms of arthritis had occurred and persisted for several years, but pain and aching had been present during the 3 years prior to her last admission. At the time of this admission she complained mainly of a constant ache in the upper part of the abdomen, with frequent nausea, flatulence, occasional light-colored stools and intolerance to fatty foods. She had not been jaundiced. Diarrhea or constipation had not been present; however, the patient had had loose stools, described as "mucus stools." There had not been any loss of weight.

Physical examination revealed a palpable tumor mass in the epigastrium and left side of the upper part of the abdomen. It was firm, irregular, not very tender and partially fixed. The essential laboratory observations are found in Table III. Results of roentgenologic examinations of the gall bladder, stomach, colon, and terminal portion of the ileum were negative, except for the duodenal ulcer.

The patient was operated on by Dr. S. W. Harrington on December 19, 1945. His report was as follows: "Upon exploration of the tumor mass in the left upper abdomen, it was found to be a diffuse area of thickening at the extreme root of the mesentery immediately over the aorta, beginning in the mesentery of the jejunum at the ligament of Treitz and extending down almost to the pelvis, involving most of the root of the mesentery of the small bowel. The area had a light yellow, milkish color. The area was about 2 to 3 centimeters in thickness at the largest part; it did not come up to the small bowel. There was an area of normal appearing mesentery at least 2½ to 3 inches from the mesenteric margin of the jejunum."

TABLE II.—INTESTINAL LIPODYSTROPHY: COLLECTED LABORATORY DATA IN CASE 2

	Feb. 1946, day		Mar. 1946, day	
Values for, or results of	11	21	5	12
Leucocytes, per cu. mm. of blood	8,500			
Hemoglobin, gm., 100 c.c. of blood	14.4	13.1		
Sedimentation rate (Westergren), mm. per hr.	16			
Urea, mgm., 100 c.c. of blood	36			
Cholesterol, mgm., 100 c.c. of plasma		134		
Cholesterol esters, mgm., 100 c.c. of plasma		98		
Fatty acids, mgm., 100 c.c. of plasma		394		
Lecithin, mgm., 100 c.c. of plasma		248		
Lipoids, total, mgm., 100 c.c. of plasma		528		
Calcium, mgm., 100 c.c. serum			9.5	
Phosphorus, mgm., 100 c.c. serum			3.4	
Protein, mgm., 100 c.c. serum A/G ratio		5.8 2.3:1		
Gastric acids (free), units (Topfer) (total)				32 42
Glucose tolerance test (Exton and Rose)				Normal
Vitamin A tolerance test				Normal
Fats, stools (average daily value)				Normal
Nitrogen, stools (average daily value)				Normal

A perforating duodenal ulcer, with moderate obstruction, was fixed to the pancreas. The other organs were found to be normal. Partial gastrectomy of the posterior Pólya type was done. A specimen of tissue from the tumor mass was taken for microscopic study (Fig. 1, c). The microscopic appearance was that of inflammatory fat. There were both intracellular fat and extracellular fat, with mononuclear foam cells and necrosis. There was infiltration of lymphocytes, with occasional polymorphonuclear and eosinophilic cell; also fibrosis in several areas.

The postoperative course was uneventful. The patient was dismissed from the hospital on the

TABLE III.—INTESTINAL LIPODYSTROPHY: COLLECTED LABORATORY DATA IN CASE 3

	Dec. 1945, day			June 1946, day	
Values for, or results of	12	14	26	18	20
Leucocytes, per cu. mm. of blood	5,600			10,100	
Hemoglobin, gm., 100 c.c. of blood	12.3			11.9	
Sedimentation rate (Westergren), mm. per hr.				20	
Urea, mgm., 100 c.c. of blood			26		
Chlorides, mgm., 100 c.c. of plasma			602		
CO_2 combining power, vols., 100 c.c. of plasma			54.1		
Cholesterol, mgm., 100 c.c. of plasma					234
Cholesterol esters, mgm., 100 c.c. of plasma					152
Phospholipoids, mgm., 100 c.c. of plasma					262
Fatty acids, mgm., 100 c.c. of plasma					369
Lipoids, total mgm., 100 c.c. of plasma					603
Proteins, total, mgm., 100 c.c. of serum					6.6
A/G ratio					2.3:1
Gastric acids (free), units (Topfer) (total)		46 56		0 6	
Vitamin A tolerance test					Normal
Fats, stools (average daily value)					Normal
Nitrogen, stools (average daily value)					Normal

twenty-second postoperative day, and from the clinic on the twenty-fourth postoperative day. She returned to the clinic on June 19, 1946, for a postoperative examination at the end of 6 months. Constant aching over the abdomen had persisted, but there had been no loss of weight. At the time of this last examination she underwent studies of abnormalities in intestinal absorption and digestion of fat. These observations are summarized in Table III. Results of all the laboratory studies were within normal limits. The patient received a course of roentgen therapy over the abdomen on four successive days. She was not given bile salts.

In all 3 cases the studies of pathologic tissue were done by Dr. John R. McDonald.

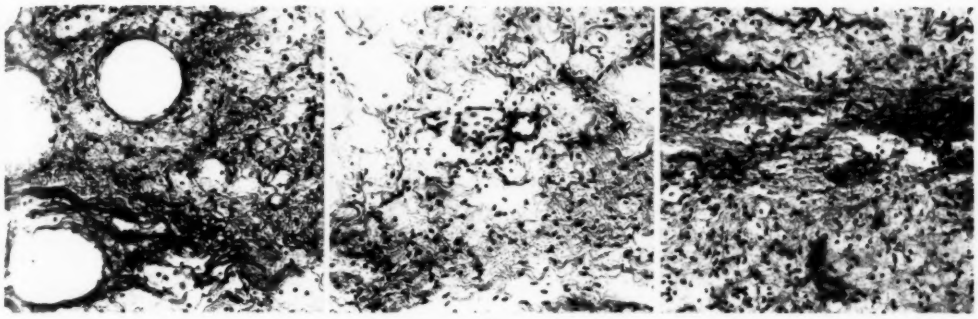
In the cases of intestinal lipodystrophy reported in the literature the anatomic data are similar enough to indicate that the condition is a definite disease entity. A brief review will be presented of the essential symptoms, physical observations, laboratory data, and anatomic characteristics in the cases thus far reported.

Clinical picture. In the 14 reported cases, 13 patients were men. The mean age was 49 years; the majority of patients were in the fifth and sixth decades. Early in the course of the disease postprandial discomfort, indigestion, and gaseous distention are noted. Later, diarrhea, severe loss of weight, progressive asthenia and general debility are present. In 4 cases the diarrhea was associated with gross blood in the stools. In 2 cases constipation was reported. The diarrhea was often associated with steatorrhea. The symptoms varied in duration from 6 months to 15 years; 9 of the patients had had distress for more than 2 years. In 6 cases there was a history of arthritis.

The physical observations are those associated with general debility. The abdomen often is described as feeling like dough at palpation, and the lymph nodes are sometimes palpated as abdominal masses. Four patients had slight icterus, two had purpura and about half had a moderate degree of dependent edema. Inguinal and axillary lymph nodes were palpably enlarged in 2 cases. In the few cases in which the disease has been so studied, results of roentgenologic examination of the gastrointestinal tract were normal.

All patients in these reported cases had moderate anemia, but only 2 had leucocytosis. Six had achlorhydria. Results of urinalysis were normal, as were results of studies of blood chemistry. Studies of stools did not disclose ova, parasites, or significant organisms. In 2 cases chemical analysis of the stool was made. In Whipple's case, 80 per cent of the dried stool was fat; of this fat, 50 per cent was neutral fat and 30 per cent was fatty acids. In Pearse's case, about 60 per cent of the dried stool was fat; 44 per cent of this was fatty acids, 12 per cent was neutral fat and 3 per cent was unsaponifiable substance. After treatment with bile salts orally, the percentage of fat in the stools of Pearse's patient decreased to 25, only fatty acids being present.

Pathologic aspects. The essential pathologic observations are present in the mesenteric portion of the small bowel and its mesentery.



a b c

Fig. 1. a, Tissue from the mesentery of the small bowel in Case 1, showing numerous mononuclear foam cells, intracellular and extracellular fat, moderate infiltration of lymphocytes and minimal fibrosis (hematoxylin and eosin, ×135); b, tissue from similar situation in Case 2, with approximately the same changes (hematoxylin and eosin, ×135); c, tissue from Case 3 with changes similar to those in the other two (hematoxylin and eosin, ×135).

Grossly, the mesentery is thickened, yellow and has a rubber consistency. The lymph nodes in the mesentery, and especially those near the root, are enlarged, firm, and on cut section often present a spongy appearance because of dilatation of the lymph sinuses. The lacteal vessels may be dilated enough to be seen grossly. The mucosa of the jejunum and ileum is either normal in appearance or is swollen and flecked with minute deposits of yellowish white lipoid. In 3 reported cases there was chylous ascites; in 7 cases fibrous pericarditis was present. Microscopic examination of the mesentery reveals marked dilatation of the lymph vessels and the presence of large mononuclear foam cells, extracellular as well as intracellular fat deposits, foreign-body giant cells, lymphocytic infiltration and fibrosis. The mesenteric lymph nodes present a similar picture. In 11 of the 14 cases the small intestine presented similar changes in the stroma of the mucosa and submucosa.

Our first patient presented only loss of weight, rapid emaciation and cramps in the lower part of the abdomen. The diagnosis was suspected on the basis of the characteristic appearance of the mesentery of the small bowel at operation, and was confirmed by microscopic examination of specimens taken for biopsy. Although this patient did not have steatorrhea, and the fat content of the stool and absorption of vitamin A were normal, the values for blood fats were low normal or subnormal at all times. Laboratory data concerning the second and third patients were entirely normal. Interestingly enough, all 3 patients were operated on because of the finding on physical examination of an indeterminate mass and relatively minor systemic or local symptoms. None had the steatorrhea or the well developed picture described by most of the other authors. All 3 patients did have some tendency toward an increase in the number of stools during the year preceding their visits to the clinic. *It is our feeling that the absence of positive results of laboratory studies in these cases is referable to the fact that the disease of the patients was, at the time we saw them, in a relatively early stage.*

Pathogenesis. Although the gross and microscopic pathologic observations have been adequately described and although the essential finding is that of intracellular and extracellular fat associated with the features of a chronic inflammatory reaction, the nature of the lipoid and the manner in which it arrives in the interstitial tissues of the involved organs are unknown. Several theories have been advanced to explain these features. Sailer and McGann said: "The essence of the pathological process appears to be a local necrosis of the fat tissue with liberation of lipolytic ferments from the damaged cells." These authors, however, did not attempt to explain either how this necrosis is brought about or the nature of the ferments. Jarcho believed that dilatation of the lymphatics, either obstructive or congenital, is the essential characteristic. Hill agreed with this

attitude and referred to Rokitansky as the first to describe this condition, in 1885, as dilatation of the mesenteric lymph nodes with chyle. Although similar dilatation also may be expected to occur in the presence of mechanical obstruction of the thoracic duct or lymphatic vessels, Fairley and Mackie have shown that patients in whom obstruction of the thoracic duct was demonstrated presented the clinical manifestations of steatorrhea without anatomic evidence of deposition of fat in the lymph nodes. In addition, in those cases of Whipple's disease in which complete necropsy has been performed, there has been no evidence of any such obstruction. Whatever obstruction was found in the smaller lymphatic vessels of the mesentery appeared to be secondary to the fibrosis which developed as a part of the pathologic picture.

The investigations of Hass tend to throw some light on the etiology of this condition and related conditions. He showed that the presence of unsaturated fat acids in interstitial tissues produced a more acute inflammatory response in which eosinophils were prominent. On the other hand, saturated fat acids in interstitial tissues were associated with the features of a chronic inflammatory process, in which giant cells, macrophages and lymphocytes were prominent. Since Whipple's disease is characterized by the latter picture, a natural supposition might be that the fat present is probably saturated, in addition to being foreign to the local tissues.

Whipple believed that the fat, in itself, is in some way abnormal or that it holds in suspension some abnormal or toxic substance. He found unusual structures in sections stained by the Levaditi method. These were vacuoles containing rod-shaped structures. These, he thought, suggested a possible relation to the Spirochaetales. He did not claim that these structures were the etiologic factors in this disease, but thought that their distribution in the nodes was very suggestive. We were unable to find these structures by means of special spirochetal stains in the sections in 2 of our cases.

Several viewpoints have been expressed in an effort to explain the manner in which the increased amount of fat proceeds to the mesentery. Reinhart and Wilson suggested that in the presence of the disease in question the excretion of fat into the intestines is increased, this in turn being followed by increased reabsorption. This would explain not only the local tissue changes but also the marked emaciation which is a feature of the disease. Korsch felt that there was a functional alteration of pancreatic lipase wherein interstitial fat was abnormally split, and the absorbed products, being foreign, acted as foreign bodies. He attempted to confirm this belief by showing that the iodine-number of the split fats in the presence of this disease is different from the iodine-number to be expected normally. Finally, Apperly and Copley mentioned that early retention of fatty substances, progressing to later development of a neoplasm, might be the essential feature.

On the basis of this short résumé it can be seen that nothing is definitely known about the pathogenesis or true nature of intestinal lipodystrophy.

Treatment. A satisfactory treatment has not been evolved; the course seems to be progressively downhill. In only 2 reported cases has any active treatment been administered. Boeck reported that after a diagnosis had been established in his case by means of results of biopsy of a mesenteric gland, a series of roentgen-ray treatments was administered. The patient, however, died several months later and at necropsy the mesenteric glands were found to be normal. Pearse's patient improved while he was receiving bile salts, calcium and vitamin A therapy, but no follow-up study has been reported. We administered a course of roentgen-ray treatments to 2 of the 3 patients concerned herein. It will be very interesting to observe the course of these patients and to note the influence of the therapy employed on the progress of the disease.

SUMMARY

Three cases of presumptive intestinal lipodystrophy (Whipple's disease), in which the patients were operated on because of an indefinite abdominal mass and whose condition was diagnosed on the basis of the appearance of the mesentery at operation, are reported. A review of the literature is presented. Since it

is our impression that in all 3 cases the disease is in a relatively early stage, it is hoped that further study of the patients concerned will throw some light on the true nature of the disease.

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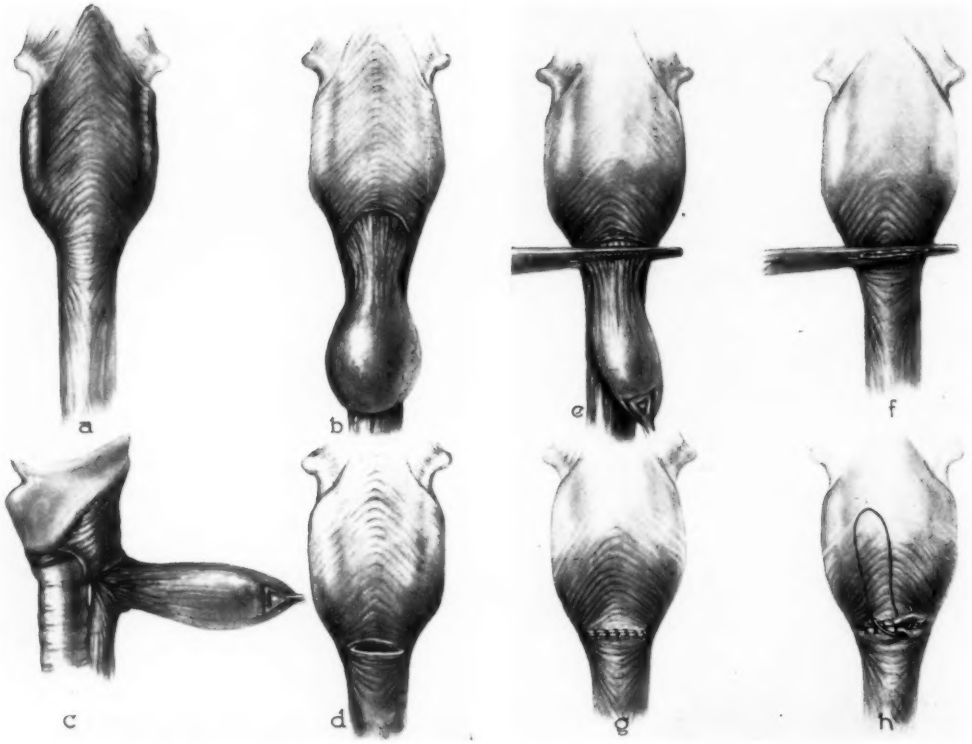

Fig. 1. a, The portion of the pharynx and esophagus with normal distribution and course of the muscle fibers of the inferior constrictor. b, The relative size of the neck of the sac and the posterior wall of the esophagus; also, the separation of the fibers of the inferior constrictor, due to the gradually enlarging neck and sac. c, The relative size of the neck of the sac and the somewhat flattened esophagus, the lateral border of which, as a rule, is seen as a flattened tube. d, Illustrates the true state of the opening in the sac as an elliptical slit rather than a round opening. e, Illustrates the forceps placed across the neck of the sac in a manner not to interfere with the circumference of the esophagus. f, The amputated sac. g, A rational method of closing the sac, so as not to interfere with the diameter or circumference of the esophagus. h, Re-enforcing row of sutures placed in the same manner as the closing row, illustrated in g. i, Partial stricture of the esophagus when a transfixion suture is employed.

New Concepts of the Etiology and Treatment of Diverticula of the Esophagus.—Brien T. King.

NEW CONCEPTS OF THE ETIOLOGY AND TREATMENT OF DIVERTICULA OF THE ESOPHAGUS

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IT is generally agreed that esophageal diverticula are correctly divided into three groups: pulsion, traction, and supradiaphragmatic; also, that a high percentage of all diverticula occur in the pharyngoesophageal region and are of the pulsion type. Those that occur in the midportion of the esophagus are of the traction type, and are due to adhesions arising from adjacent inflammatory lesions. No one seems to be too certain of the etiology of the supradiaphragmatic type. They are rare, and there are reasons for believing that they may be due to inflammatory lessions, plus pulsion force, accompanied by varying degrees of obstruction at the cardia. This paper is limited to pharyngoesophageal diverticula.

Diverticula of the esophagus may be compared to inguinal hernia and, like it, ascribed to congenital muscular weakness, plus a pulsion force, causing the protrusion of a viscus, or lining, through the weakened area. The present accepted theory of the origin of diverticula, is that they occur as the result of a congenital weakness, or separation, between the fibers of the inferior constrictor muscle of the pharynx, and those of the cricopharyngeal muscle, and that during swallowing, the cricopharyngeal muscle is slow to relax, resulting in more than normal pulsion force on the unsupported area of the posterior pharyngeal or esophageal wall, and that repeated applications of that force, in swallowing, causes at first a bulging of the esophageal wall through the area with ultimate sac formation. I have no criticism of the theory except on the basis of the condition being due to congenital weakness, the result of separation of fibers of the cricopharyngeal and inferior constrictor muscles. With the place at which it occurs and the manner in which it develops, I am in accord, but with the theory that there is a congenital weakness at the site of protrusion of the sac, there seems to be a reasonable doubt.

It is my belief that a diverticulum occurs at the site of an acquired defect rather than of a congenital one, for the reason that I know of no case of esophageal diverticulum, occurring prior to the age of 15 years or prior to the age when the larynx has maturely developed. It is only after mature development of the larynx that it is large enough to create pressure against the cervical vertebrae, and from my observations, it is at the point where the lower border of the cricoid cartilage rests against the cervical spine that all diverticula of the pharyngoesophageal type develop.

Most anatomists do not agree that there is a cricopharyngeal muscle as a separate entity from the inferior constrictor. After doing 40 odd dissections of the larynx and pharynx, including the inferior constrictor, plus 87 operations for bilateral cord paralysis, during the course of which there was fair opportunity to observe the pharyngoesophageal region, plus a number of operations for the removal of diverticula, I came to the conclusion "that the cricopharyngeal muscle is that portion of the inferior constrictor, the fibers of which pass transversely, and are attached to the cricoid cartilage, just below the inferior cornu of the thyroid cartilage." There are additional fibers which fan out from the lower border of the constrictor muscle and pass longitudinally and diagonally down the upper end of the esophagus. The upper end of the esophagus has few longitudinal fibers other than those given off from the inferior constrictor.

There is a small ridge created at the site of all intervertebral joints, and the lower border of the cricoid cartilage frequently rests against the ridge of the fifth cervical vertebral joint. It is my conclusion that the pressure of this ridge against the lower border of the cricoid cartilage results in thinning of the inferior constrictor muscle and the posterior esopha-

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geal wall at this point of pressure. The cricoid cartilage does not rest against the same vertebra or vertebral joint in all individuals. Its position depends on the stature of the person and the length of neck. It may rest against the lower border of the fourth cervical vertebra, but usually rests about opposite the fifth joint, although it may be lower. There is some reason to believe that in individuals with more than average anterior curvature of the cervical spine, the cricoid cartilage rests more firmly against the spine.

Further reasons are that the upper portion of the posterior surface of the cricoid cartilage does not rest against the spine, as does the lower portion, and it is here that herniation occurs. Just below the lower border of the cricoid cartilage the transverse fibers of the constrictor pass beneath the cartilage creating a shelf-like fold. Chevalier Jackson has designated this portion of the muscle, described as a pinchcock muscle, which closes the opening of the esophagus, except during swallowing and regurgitation, and believes that the muscle does not always co-ordinate its functions with the fibers of the inferior constrictors which are above the transverse fibers and have the general description of an inverted "V."

Diverticula occur three times as frequently in men as in women. The male larynx is, on the average, one and one-half times the anteroposterior diameter of the female. Men are more muscular, and the larynx is consequently held more firmly in contact with the spine. I recently saw a man who sustained a compression fracture of the fifth cervical vertebra with slight anterior displacement of the body of the vertebra, the pressure of which caused a bilateral recurrent nerve paralysis and, within a few days, necessitated a tracheotomy. I have seen decubitus ulcers develop in the esophagus or hypopharynx, on the posterior surface of the cricoid cartilage, from the pressure of a nasal feeding tube. In one instance, a bilateral cord paralysis resulted, in the other, a unilateral paralysis. Other cases are reported resulting in mediastinitis. Surgical literature abounds with reports of such complications. The development of such ulcers serves to prove the firmness with which the cricoid cartilage is held in contact with the spine. I do not know that it is a matter of importance as to whether or not one wishes to think of the constrictor mechanism at the junction of the pharynx and esophagus as comprising one or two muscles. It is mentioned only because the foregoing explanation of the etiology of the pharyngoesophageal diverticula seems more logical than that of a congenital hiatus in the mechanism. For proof of the firmness with which the larynx is held against the spine, simply grasp your own larynx between your thumb and index finger. It is easily displaced laterally. Now try to press it backward, and you will see that it is held firmly against the spine.

While making fluoroscopic examinations of patients with diverticula of the esophagus, it was observed that the first swallow of barium mixture entered the diverticulum and only when it was filled did any pass into the esophagus, and that the fluid level at the opening of the sac approximated the width of the esophagus.

The spill-over of barium mixture from the opening in the sac, when observed under the fluoroscope, is an accurate measure of the width of the diverticulum opening. If an x-ray photograph be made at the moment when the diverticulum is completely filled, the fluid level will represent an accurate determination of the width of the opening. These observations caused me to alter my plan of dealing with the neck of the amputated diverticulum. In intestinal surgery, sound principles dictate that the surgical closures of the bowel be done in a manner so as to create the least disturbance of the lumen of the bowel. The same principle applies to esophageal surgery.

Jackson and Jackson, in the book entitled *Diseases of the Nose, Throat and Ear*, page 594, published in 1945, state "The esophagoscope will without difficulty, enter the sac which is really the whole bottom of the pharynx, and will be arrested by the blind end of the pouch, the depth of which may be from 4 to 10 cm." The opening at the mouth of the sac, so dominates the hypopharynx that the passage of rigid instruments either for the purpose of examination, or as part of operative technique, is a dangerous procedure, except in the hands of those highly skilled in the use of

such instruments. I have seen one patient who died as a result of mediastinal infection caused by perforation of the sac by passage of an esophagoscope through the pouch of the diverticulum. Some surgeons have recommended insertion of an illuminated instrument into the sac as a means of identification during its removal. Because of such accidents I would hesitate to employ that method.

In a majority of instances, diverticula are said to shift toward the left side of the midline of the neck. It is my opinion that this tendency is due to the fact that the distended sac bulges in the direction of least resistance which is to the left side. The left common carotid artery is farther removed from the trachea and esophagus, than the right. The innominate artery and the left common carotid both arise from the arch of the aorta, on the left side of the midline. The innominate artery crosses in front of the trachea and divides into the right common carotid and subclavian. A line from the point of origin of this vessel to the foramen lacerum, crosses the trachea and lies closer to its right border, than a similar line following the course of the left common carotid, which runs an almost perpendicular course, from its point of origin to the corresponding foramen, on the left side. The only diverticulum which I have encountered, causing a visible bulge in the neck, protruded to the right. For a right handed surgeon, the regions and structures lying behind the larynx, pharynx, and esophagus, are easier to approach from the left side.

The preoperative preparation of the patient is important. Only liquid and soft foods should be given for at least 24 hours before operation. The evening before operation, the patient should be instructed to lavage the sac on two or three occasions by swallowing water, then lie down and empty the sac by strong swallowing efforts. One hour later, 1 or 2 drams of a 10 to 20 per cent solution of tincture of metaphen, or tincture of merthiolate, is administered with instructions to swallow it with one effort, and to refrain from any effort to empty the sac. This is done for the purpose of reducing the bacterial content of the sac. How effective this is, I do not know. In any event, it does no harm. In our experience, no infections or fistulas have occurred following the one stage operation. A high percentage of the wounds following the two stage operation have had some degree of infection. This is believed to be due to the presence of gauze packing placed in the wound and left in place for a period of a week or more.

TECHNIQUES

Either local or general anesthesia may be used in the operation. My preference is sodium pentothal. The combination of nitrous oxide and ether is also satisfactory. Inflammable gases are undesirable because the cautery or coagulation current is a valuable agent in searing the severed end of the sac. Local block anesthesia is satisfactory. It has one advantage in that the conscious patient's co-operation can be secured during the exposure of the neck of the sac, and determination of where the neck of the sac begins and the wall of the esophagus ends, is more easily made. The act of swallowing helps in determining the junction point. A suction device should be present for the purpose of removing, from the pharynx, any contents of the sac which may be extruded into the pharynx, during manipulation of the sac.

As a rule, the left side is the location of choice for making the incision; however, if by fluoroscopy, or other examination, the sac seems to lie more to the right, a right side incision becomes the location of choice. An incision, 2.5 to 3 inches long, is made just anterior to the border of the sternomastoid muscle. Some surgeons prefer a transverse incision, which results in a better scar. The incision extends through the skin, platysma muscle, and deep cervical fascia. The omohyoid muscle is ligated, divided, and separated from the sternothyroid muscle. The muscle is retracted outward; the exposed outer border of the thyroid gland is retracted forward. The middle thyroid vein and inferior thyroid artery are ligated and divided if in the way. I have not always found this necessary. The carotid sheath is separated from the esophagus, by passing the finger upward and downward, along the space between it and the common carotid artery. The dissection should be carried high enough to expose the lateral border of the larynx and those fibers of the

inferior constrictor which surround the hypopharynx. This exposes the lateral borders of the esophagus and sac, except in cases of small diverticula. In the event the sac is not readily identified, the loose space behind the esophagus and larynx should be opened or separated and the finger passed upward until the lower border of the cricoid cartilage is felt. The neck of the sac will always be found in the region of this constant point of identification.

A diverticulum begins as a small budlike bulge in the posterior wall of the hypopharynx or the upper margin of the esophagus. As it enlarges, the fibers of the inferior constrictor become further separated by the enlarging neck of the sac. Some of the thinned fibers fan out over the neck on its upper and lateral surfaces. A very sharp angle is created on the lower or undersurface of the neck of the sac, where it leaves the esophagus. At this point, some of the transverse fibers become rolled into a sort of bundle, or cord, over which the neck of the sac is suspended. This bundle of fibers should be divided and laterally separated, and later may be used to cover the line of sutures closing the amputated neck of the sac. They should not be left to create another shelf-like fold in the posterior wall of the esophagus. All other muscle fibers should be removed from the neck of the sac, so as to provide a good view of its entire circumference.

It is important to determine carefully where the neck of the sac begins and the wall of the hypopharynx or esophagus ends. Caution should be exercised in removing muscle fibers from the neck of the sac, as it is quite thin and easily perforated. When the junction point has been determined, it will be observed that the neck of the sac is practically the same size, width, or diameter as the esophagus.

The method of closing the neck of the sac is of greatest importance. If, as has been recommended by some surgeons, a transfixion and ligation suture be used, then practically one-half the circumference of the esophagus may have been destroyed and an immediate narrowing or partial stricture created. If the transfixion and ligation suture is too far removed from the esophageal wall, a dimple will result, which is an invitation for recurrence of the diverticulum.

During the last 3 years, I have devised and used a method of removing the sac and closing its neck that has proved entirely satisfactory. This procedure is based on sound anatomic and surgical principles; a description follows.

In the resting state, the opening of the sac is not a small round hole in the posterior wall of the esophagus, but an elliptical slit, occupying the entire diameter of the esophagus (see Fig. 1, d). When the neck of the sac has been entirely freed and traction has been made upon its fundus, the elliptical opening becomes rounded because of traction. The fundus is then grasped with an ordinary pair of triangular bladed forceps, the sac is freed, and the surrounding muscle fibers divided as previously described. It should be remembered that at the point of junction the esophagus and diverticulum make up a double barrelled tubular arrangement, comprising two flattened tubes, each about 1 inch in diameter, one of which is immediately in front of the other. When the sac is freed and traction is put upon it, instead of the barrels occupying a parallel position, the sac then occupies a right angle position. A narrow bladed forcep, of the Rankin or similar type, is placed across the neck of the sac at the point of junction. This forcep does not interfere with or include any of the circumferential wall of the esophagus, and no narrowing or stricture is produced. It leaves the diameter and circumference undisturbed. A second forcep is placed parallel to the first and the neck of the sac is amputated between the two. The cut edge of the sac is seared by electrocoagulation and painted with tincture of metaphen. A No. 00 chromic catgut suture on an atraumatic needle, is passed through both walls of the remaining amputated stump, immediately behind, and next to the lock of the forcep. It is tied and continued for a couple of loose turns. This forcep is then removed. The suture is tightened and continued as a running suture (Fig. 1, g), where it is again tied at the other side of the amputated neck of the sac. The suture should not be pulled taut enough to cause puckering of the closure. A second row of a similar running stitch is then placed infolding the first (Fig. 1, h). A few interrupted sutures, picking up the divided muscle fibers, may be used to

further reinforce the closure; this, however, is not important. A little confusion may be encountered in placing the forcep at a right angle across the neck of the sac. This results because the upper end of the esophagus and the hypopharynx are anchored respectively to the posterior surface of the cricoid cartilage and the lateral borders of the thyroid cartilage. The esophagus, therefore, cannot be rotated as a flattened tube, when tension is made on the sac. One must make allowance for the altered relationship of the sac and the esophagus at this stage of the operation. It may be found convenient to place the forceps somewhat diagonally upward, and downward, across the neck of the sac.

At this time a small feeding tube may be introduced through one nostril, and guided down the esophagus. We have not regularly used a feeding tube and are not convinced that it is necessary or even desirable. When used, 4 days has been the maximum time it has been left in place. When the closure is complete, the wound is lavaged and a few sulfathiazole crystals are dusted (not dumped) into the wound. Penicillin may be substituted. A small Penrose drain is inserted and left in place for 48 hours. The omohyoid muscle is sutured and the wound is closed with interrupted catgut and skin clips.

Nothing by mouth is given for 2 days. If a feeding tube is used, liquids are administered through it for 3 or 4 days. If not used, intravenous fluids are given for 48 hours. Fluids by mouth are begun in 48 hours.

During the last 3 years, this operative procedure has been employed on 11 patients, with no infections, no fistulas, or other complication. Postoperative dilations have not been necessary. The patients were hospitalized for 3½ to 7 days.

Prior to that time, when the two stage operation was employed, three fistulas and a high percentage of infected wounds resulted. One death occurred several years ago in a very much emaciated arteriosclerotic woman, aged 75 years, the result of a coronary occlusion, 24 hours after the first stage of an uncomplicated operation. This cannot be attributed to the two stage method.

In my experience, the removal of pharyngoesophageal diverticula has not been a difficult operation, except in the case of one small diverticulum, which when empty, was so contracted that it lay immediately behind the larynx and was difficult to find. I suggest that if one has difficulty in locating the sac, the space behind the upper end of the esophagus be opened. This is easily done because of the loose connective tissue occupying that region. Then pass the finger upward behind the esophagus and larynx, until the lower border of the cricoid cartilage is felt. The neck of the sac will always be found in the immediate vicinity of the lower border of the cricoid cartilage. In large diverticula, the sac is usually easily identified, and the above procedure will be unnecessary.

If one is familiar with the anatomy of this region and understands the mechanics of the pharynx and esophagus and the development of an esophageal diverticulum, there should be no difficulty in effecting a cure by a one stage operation.

TUMORS OF THE GASTROINTESTINAL TRACT

A Survey of 813 in Persons of Military Age during World War II

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THE gastrointestinal tract proved to be a favorable site for the development of tumors in persons of the Army age group. As a result, specimens from the digestive tract made up one of the largest sections of the entire collection for the period of World War II at the Army Institute of Pathology. It seemed appropriate, therefore, to make a thorough survey of these tumors, emphasizing their relative frequency, anatomic distribution, histologic characteristics, and pertinent clinical features. By this study many well known facts have been given emphasis and a number of little known facts have been brought to light and, to some extent, clarified.

Eight hundred and thirteen tumors of the gastrointestinal tract arising in Army personnel between the ages of 18 and 38 were examined at the Institute between December 7, 1941, and August 15, 1945. Anatomically, the lesions were situated between the pharnygoeosophageal junction and the anus; those arising in the buccal cavity and pharynx form the basis of a separate report. Almost all of these tumors constituted a primary, new disease in a previously healthy individual; a few were discovered at autopsy in patients dying from other causes. The diagnoses under which the specimens were classified can be accepted with a considerable degree of finality in view of the fact that most of the lesions were not of controversial character.

MATERIAL

The statistical studies incorporated herein are based entirely on the records at the Army Institute of Pathology. No attempt was made to conduct an independent analysis of the gross anatomic material or the histologic sections. In the vast majority of cases a reasonable unanimity of opinion was reached by the pathologists who reviewed the material. In some instances unresolved differences of opinion were evident in the records and in such cases it was necessary for the authors to decide, in the light of available information, in which category to place the lesion for statistical purposes.

The 813 lesions selected for analysis occurred almost entirely in enlisted or officer personnel of the Army of the United States. Occasional specimens were obtained from prisoners of war and internees of relocation centers. Seven hundred and forty-nine were found in white, 58 in negro, and 6 in mongolian patients. This distribution is consistent with the ratio in overall Army population. Forty-two of the patients were women.

The lesions were classified from a cytogenic standpoint and the results are summarized in Table I. A few specimens not strictly regarded as neoplasms were included for their general clinical and morphologic interest. In Table V all the varieties of tumor found in the gastrointestinal tract are listed according to their anatomic location.

CARCINOMA

There were 441 carcinomas in the group; they are subdivided by location in the gastrointestinal tract and by age of the patient in Table II, and the percentage of fatality is listed. It is evident in this table that approximately half of the cancers of the large intestine occurred in the rectum (171:169). Carcinomas of the large intestine (including rectum) made up 77 per cent of the malignant epithelial tumors.

There were 26 cancers in the 18 to 20 year age group, 198 in the 21 to 30 year group, and 217 in the 31 to 38 year group. In Chart 1 the same figures are expressed per 100,000 mean strength of the Army from December 7, 1941 to August 15, 1945. According to these

From The Army Institute of Pathology, Washington, D. C.

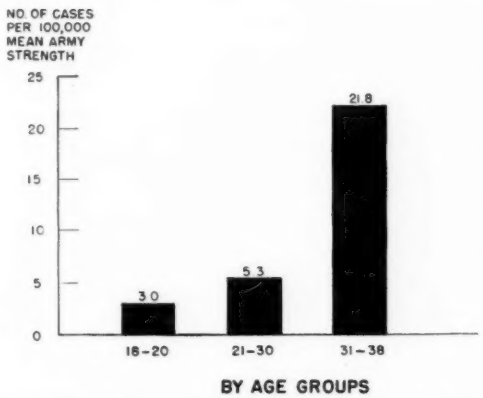

Chart 1. Carcinomas of the gastrointestinal tract. Comparison between age and location.

TABLE I.—CYTOGENIC CLASSIFICATION OF TUMORS SURVEYED

Epithelial origin		Reticulum cell sarcoma	4
Adenoma (polyp)	158	Lymphosarcoma	16
Carcinoma	441	Leucemia	1
Carcinoid	76	Hodgkin's disease	1
Smooth muscle origin		Miscellaneous	
Leiomyoma	12	Undifferentiated sarcoma	1
Leiomyosarcoma	3	Melanoma, primary	1
Vascular origin		Melanoma, secondary	6
Hemangioma	1	Adenofibroma	1
Hemangiopericytoma	1	Myoepithelial hamartoma	2
Nerve tissue origin		Ectopic pancreas	16
Neurofibroma	4	Cyst	8
Ganglioneuroma	1	Endometriosis	3
Connective tissue origin		Pneumatosis cystoides	1
Fibroma	2	Total	813
Reticuloendothelial origin			
Benign lymphoid polyp	53		

figures there were 3 per 100,000 in the 18 to 20 year age group, 5.3 per 100,000 in the 21 to 30 year age group, and 21.8 per 100,000 in the 31 to 38 year age group.

Esophagus. There were 8 instances of carcinoma of the esophagus. That 5 occurred in negroes is possibly a coincidence. All of the patients with carcinoma of the esophagus were over 21 years of age; 4 were in the third decade, and 4 in the fourth. There were 3 known fatalities at durations of 3, 5, and 8 months, respectively. Seven of these tumors were of the squamous type and these were located 1 in the upper, 3 in the mid, and 3 in the lower portion of the organ. The 1 adenocarcinoma was found in the middle third and apparently arose from the esophageal glands. Two tumors eroded the carotid artery, but there were no other unusual clinical features.

Stomach. There were 75 primary carcinomas of the stomach, 2 of which were acceptable as true ulcer carcinomas on the basis of the following criteria, i.e., long standing clinical history of ulcer symptoms, characteristic gross appearance of peptic ulcer, and microscopic evidence of carcinoma in part of the ulcer wall.

The age distribution for the 75 cases was 4 under 21 years, 37 between 21 and 30 years, and 34 between 31 and 38 years. All of the patients were white males except 1 female, 2 negro males, and 1 mongolian male.

In this group the number of known fatalities was 50, significantly higher than in any other category of gastrointestinal cancers. This figure is probably an expression of continued postoperative hospitalization of a high percentage of the patients, because they were too acutely ill to be moved to Veteran's Hospitals. The general practice was to transfer patients with carcinoma when they had received maximum benefit in Army hospitals.

In the 50 fatal cases the average duration from onset to death was 7 months; the short-

TABLE II.—CARCINOMAS OF THE GASTROINTESTINAL TRACT IN RELATION TO AGE AND FATALITIES

Age	Esophagus		Stomach		Small intestine		Appendix		Large intestine		Rectum		Anus		Total		
	Case	Fat	Case	Fat	Case	Fat	Case	Fat	Case	Fat	Case	Fat	Case	Fat	Case	Fat	% Fat
18–20	0	0	4	3	0	0	0	0	10	7	12	5	0	0	26	15	58
21–30	4	0	37	27	3	2	5	0	72	26	76	15	1	0	198	70	35
31–38	4	3	34	20	6	3	2	2	89	34	81	10	1	0	217	72	33
Totals	8	3	75	50	9	5	7	2	171	67	169	30	2	0	441	157	36
% Fat	38		67		56		29		39		18		0		35		

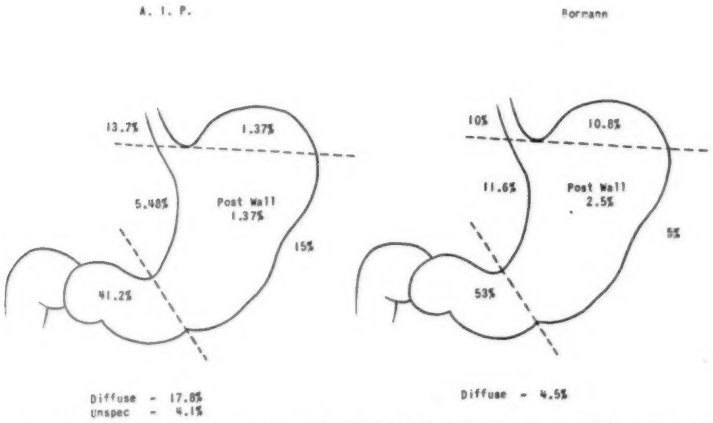

Chart 2. Gastric carcinoma in Army Institute of Pathology series, at left, compared with Bormann's figures, at right.

est recorded was 2 weeks, and the longest 26 months.

The location of the primary tumors is summarized in Chart 2. A comparison with published statistics shows a rough similarity in distribution.

In 45 cases the histologic variety was specified; the findings are presented in Table III.

A review of the clinical data incorporated in the records brought out no unusual details. Positive roentgenologic interpretations were made in 31 cases; 5 of the tumors perforated spontaneously; ascites was recorded in 31.

Small intestine. There were 9 cases in which the diagnosis was primary carcinoma of the small intestine; 8 of them were adenocarcinoma and 1 was a mucous cell carcinoma. Two arose in the duodenum, 4 in the jejunum, and 3 in the ileum. There were 7 white males, 1 white female, and 1 mongolian male in the group. Four of these patients are known to have died, the duration from onset of symptoms to death being 2, 5, 6, and 13 months. In one of these cases the diagnosis was confirmed on the basis of malignant cells in the sediment from ascitic fluid.

Appendix. Seven carcinomas of the appendix were reviewed; 1 from a patient under 21, 3 from patients in the third decade, and 3 in the fourth. Two of these patients died, the known duration of the disease being 5 and 13 months. The clinical diagnosis of acute appendicitis was made in almost every case and the true nature of the disease discovered only at operation or post mortem. Histologically, 5 out of the 7 cases were adenocarcinoma, 2 were mucinous; in 1 of the latter, pseudomyxomatous peritoneal implants were encountered.

Large intestine. From the large intestine (not including the rectum and rectosigmoid) 171 carcinomas were removed. Ten of these occurred in patients under 21, 72 in patients in the third decade, and 89 in patients between 31 and 38. The total of 171 cases constitutes almost 40 per cent of all tumors of the gastrointestinal tract. The general distribution of these tumors is shown in Chart 3 and the relative percentage in each anatomic location follows rather closely those in published surveys (e. g., Oberndorfer, etc.). The histologic types encountered are indicated in Table IV.

TABLE III.—HISTOLOGIC TYPES OF GASTRIC CARCINOMAS

Adenomatous	30	Colloid	3
Scirrhous	23	Polypoid	31
Medullary	3	Anaplastic	2
		Ulcer	2

TABLE IV.—HISTOLOGIC TYPES OF CARCINOMA OF THE LARGE INTESTINE

Adenomatous	90	Papillary adenomatous	15
Mucous	33	Scirrhous	6
Medullary	23	Adenoacanthoma	1
		Undifferentiated	2

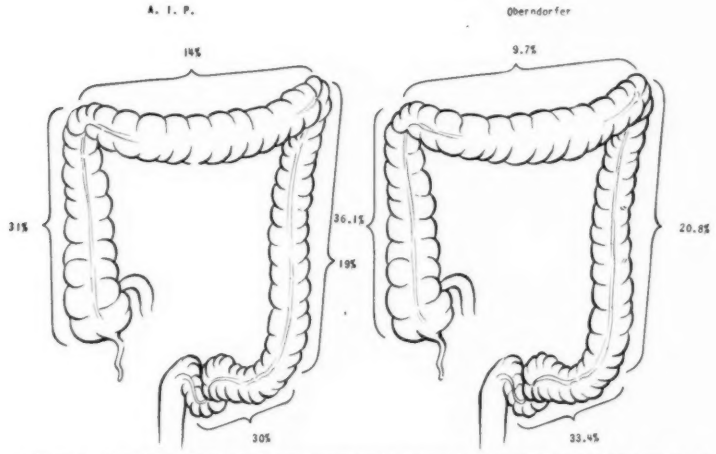

Chart 3. Carcinomas of the large intestine in Army Institute of Pathology series, at left compared with Oberndorfer's figures, at right.

There were 12 females in this series; all other patients were white males except 17 negro males and 2 mongolians. These figures are approximately the racial ratio in the population.

At the time figures were compiled for the survey there were 67 known fatalities. Death had occurred at an average interval of 8 months from the onset of the disease, the longest duration recorded was 48 months.

TABLE V.—DISTRIBUTION OF ALL TUMORS

	Esophagus No.	Stomach No.	Small intestine No.	Appendix No.	Large intestine No.	Rectum No.	Anus No.	
Carcinoma	8	75	9	7	171	169	2	441
Carcinoid		1		65		10		76
Adenomatous polyp	1	3	7	2	10	105	14	142
Polyposis			3		3			6
Polyp with atypism						10		10
Lymphoid polyp						53		53
Lymphoma *5		4	7	1	4			17
Leucemia		1						1
Leiomyoma	2	9	1					12
Leiomyosarcoma		2	1					3
Melanomas *2			4		1			5
Neuromas				5				5
Fibromas	1	1						2
Hemangiomas		1	1					2
Hamartomas		5	14					19
Undifferentiated sarcomas			1					1
Cysts	4		5					9
Endometriosis			1	2				3
	16	102	54	82	189	347	16	806

*Multiple sites in G-I tract.

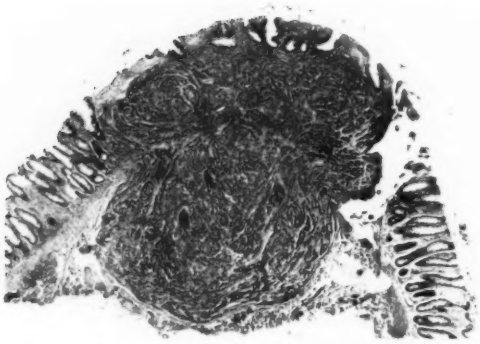

Fig. 1. Carcinoid of the rectum showing an invasive but at the same time circumscribed character. (×15. A.I.P.[1] Acc. 125150.)

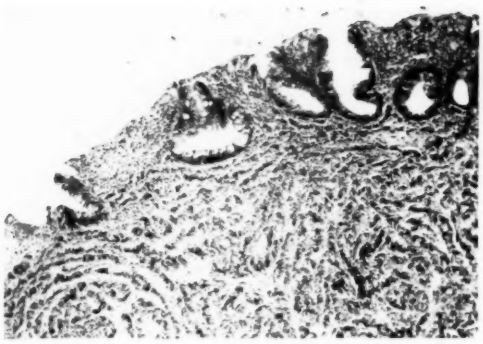

Fig. 2. Carcinoid of the rectum showing relationship to the mucosa and stretching effect. (×115. A.I.P. Acc. 125150.)

Positive roentgenologic diagnosis had been made in 63 instances. Sixty-six of the tumors were severely ulcerated and 26 had perforated. Significant ascites was noted in 34 cases.

Rectum. Carcinomas of the rectum total 169, 38.6 per cent of the entire number of cases in the series. The carcinomas of the large intestine and rectum together make up approximately 80 per cent of all the neoplasms of the intestinal tract. Twelve of the rectal carcinomas occurred in patients under the age of 21 years, 76 in patients in the third decade, and 81 in those between 31 and 38. Fourteen of the patients were negroes and 1 a mongolian. There were 8 women with rectal cancer. Known fatalities in this series number 30 and occurred after an average interval of 8 months, the longest being 25 months and the shortest 2 months. Positive roentgenologic evidence was recorded in 25 cases. Eighty-five of the tumors were markedly ulcerated and 9 were perforated. Significant ascites was noted in 11 cases. The exact location of the lesion was not specified in 92 cases, but for the remaining 78 the distribution was as follows: in an anorectal location, 4 were situated between 1 and 10 centimeters and 44 between 10 and 30 centimenters from the anus; 18 were in the rectosigmoid. The inference here is that well over half were palpable to the examining finger. The histologic type was listed as adenocarcinoma in 127 cases, mucous cell carcinoma in 29, and papillary adenocarcinoma in 6. The

[1]A.I.P., Army Institute of Pathology.

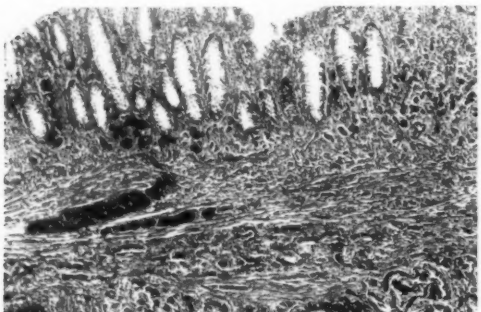

Fig. 3. Carcinoid of the rectum. Clusters of cells in the mucosa with extension into the deeper tissues. (×45. A.I.P. Acc. 121025.)

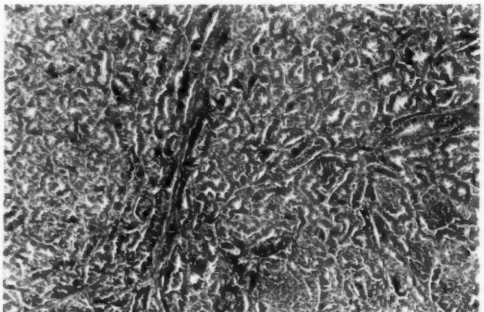

Fig. 4. Carcinoid of the rectum. Ribbons and festoons of cells mixed with a few solid nests. (×45. A.I.P. Acc. 121025.)

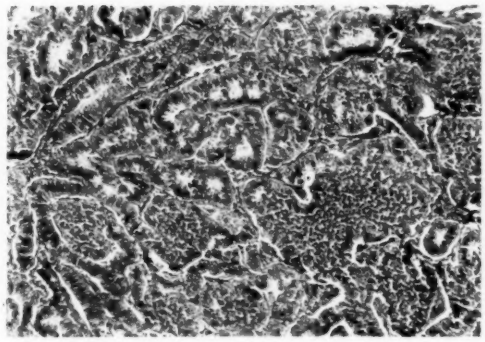

Fig. 5. Higher power of Figure 4 showing the characteristics of the cells. The nuclei are somewhat vesicular. The ribbon-like streamers are characteristic. (×90.)

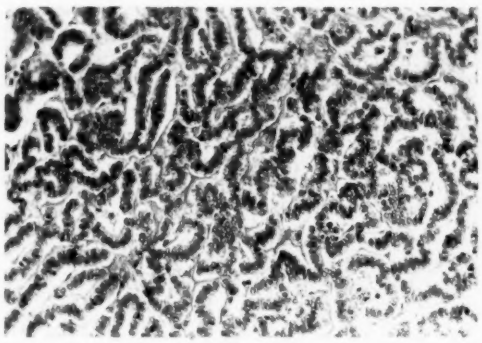

Fig. 6. Higher power of Figure 4 in area of festooning ribbons. Picture is a characteristic field of rectal carcinoid and differentiates it from carcinoids elsewhere. (×115.)

general findings at autopsy with regard to local extension of the disease, metastatic involvement of other organs, and complications conform generally to accepted concepts.

Anus. There were 2 anal carcinomas; both of these occurred in white males whose ages were 27 and 34 years. The initial symptom in each instance was rectal bleeding; examination disclosed papillary lesions at the anocutaneous junction. The diagnosis established by biopsy in both cases proved to be squamous cell carcinoma.

POLYPS

It was decided for the purposes of this study to attempt to maintain a separate category for all polypoid glandular lesions which were not frank carcinomas. Many lesions of the type classified in some institutions as adenocarcinoma, grade 1, were designated in our series as adenomatous polyps. Furthermore, all lesions diagnosed as "adenoma malignum," "adenomatous polyp with cellular atypism" or "adenomatous polyp with early carcinomatous transformation," which on review by the authors could not be classified as invasive, were placed in the polyp group. Three cases of diffuse polyposis of the large intestine were included and also rare instances of glandular polyps in the esophagus, stomach, small intestine, and appendix. Various nonglandular polypoid lesions such as benign lymphomas and polypoid carcinoids are enumerated else-

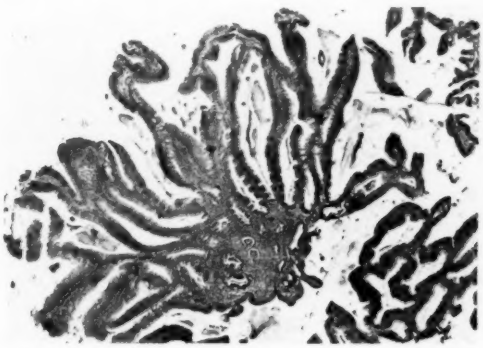

Fig. 7. Photomicrograph of a villous adenomatous polyp of the rectum. The long fronds are seen to be lined with basophilic atypical cells and there is present an early malignant invasion of the stalk. (×15. A.I.P. Acc. 162421.)

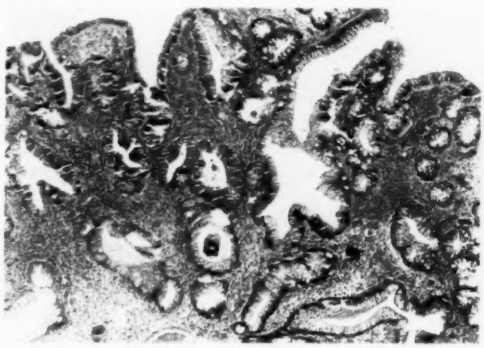

Fig. 8. Rectal polyp with "atypism." Some crypts show bifurcation while others are simple indentations. The bifurcated crypts are lined with basophilic, large, irregular cells with varying amounts of mucus. These are termed "with atypism." (×75. A.I.P. Acc. 105178.)

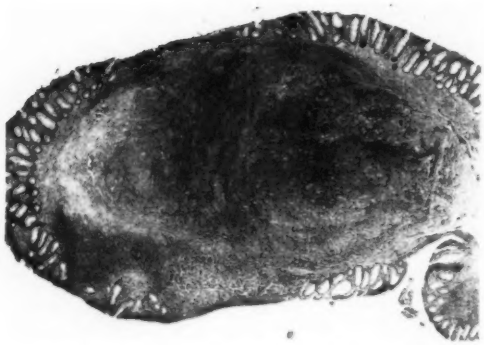

Fig. 9. Benign lymphoid polyp of the rectum. The body of the polyp is composed of hyperplastic lymphoid tissue with scattered secondary nodules. These lesions have been cured by local excision and have never been followed by malignant changes in the 53 seen at the A.I.P. (×15 A.I.P. Acc. 147192.)

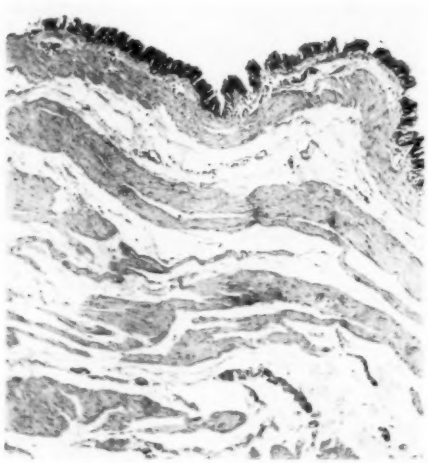

Fig. 10. Esophageal cyst found in wall of esophagus, lined with columnar epithelium. The muscularis propria surrounding it is a part of the esophageal wall. (×45. A.I.P. Acc. 134726.)

where in this survey. Glandular polyps which were discovered in the intestinal tract during autopsy, when death had resulted from other causes, were not included in this series. It follows, therefore, that the polypoid lesions of the intestinal tract in the present series were nearly all instances of a primary clinical disease. Only a general statistical survey of adenomatous polyps has been attempted. Analysis of this material as to its relation to the genesis of cancer of the intestinal tract would need to be the object of a special study.

The 3 instances of diffuse polyposis of the large intestine all occurred in white males and all terminated fatally, with death the result of surgical complications. Adenomatous polyps totaled 138; 105 of these were located in the rectum; the remainder were distributed throughout the intestinal tract as indicated in Figure 8. In 10 instances the diagnosis bore the qualifying phrase "with cellular atypism" or "with early carcinomatous change." There were no fatalities recorded in the entire group. There were 12 females in the series, 11 negro males, and 1 mongolian male. So far as is known all

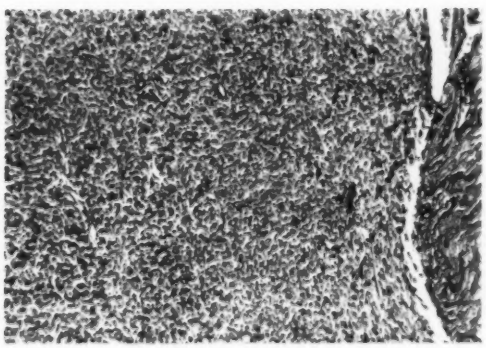

Fig. 11. Hemangiopericytoma of stomach. Tissue on right is fibrous connective tissue. Tumor tissue has a vascular background but cells are almost entirely smooth muscle cells, pericytes of small vessels. (×75. A.I.P. Acc. 126447.)

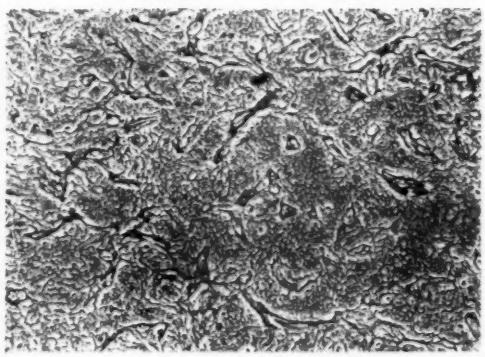

Fig. 12. Hemangiopericytoma of stomach. Wilder reticulum stain to bring out the highly vascular character and arrangement of reticulum in relationship to the vessels. (×75. A.I.P. Acc. 126447.)

of these lesions were treated by local surgical eradication, and in some, secondary and even tertiary operative procedures were carried out for the removal of additional polyps. There were no instances in this series in which there was subsequent clinical evidence of malignancy. This would be expected from the arbitrary manner these cases were selected and from the fact that the polyps were excised.

CARCINOIDS

Of the 76 carcinoid tumors found in the gastrointestinal tract 65 were in the appendix; 10 of the remaining 11 took their origin in the rectum and 1 in the stomach. Twelve of the patients were under 21 years old, 44 between 21 and 30, and 9 between 31 and 38. The age distribution in this group is definitely younger than in the carcinoma group. Seven females and 2 negro males were in the series. Detailed information with regard to regional infiltration and extension to neighboring tissues and lymph nodes was available in a few instances, but no attempt was made to evaluate these features statistically because of the sketchy character of the records. There is no instance of fatal outcome, nor were any specimens diagnosed as malignant carcinoid. All of these tumors belong histologically to the classical type of carcinoid with the exception of the rectal group, most of which had histologic features similar to those described by Stout under the designation of "pre-enterochrome argentaffinoma." There were 10 of these tumors; they were characterized by ribbons of cells arranged in complicated curls and festoons. They were free of lipid substances and attempts to demonstrate silver-reducing granules were unsuccessful. Nevertheless, these tumors were classified as carcinoids; they will constitute the subject matter of a separate report. The identification of these lesions evidently proved difficult, for a number of them were regarded as adenocarcinomas at the time of the first examination. None of these lesions was treated by radical measures and so far as is known no case has been complicated by local invasion or metastasis after removal of the carcinoid.

Benign lymphoid polyp. There were 53 cases with the diagnosis of "benign lymphoid polyp of the rectum." The lesions conformed clinically and anatomically to those described by Dukes and by Hayes, Burr, and Pruit. The age distribution was 3 under 21 years of age, 16 between 21 and 30, 11 between 31 and 38 years, and 23 unspecified. Three of the patients were female, 2 were negro male. The disease was cured by local removal; there was no record of recurrence or of fatal outcome.

LEIOMYOMAS

There were 17 tumors of smooth muscle origin in the series. Fourteen of these were benign leiomyomas while the remaining 3 were recorded as leiomyosarcomas. The 14 benign tumors occurred in the esophagus (3), stomach (10), and small intestine (1). All 14 were found in males, 4 of them negroes. In most instances these tumors were incidental findings at autopsy; however, several of them produced symptoms which necessitated surgery, and death occurred from postoperative complications in 2.

Of 3 leiomyosarcomas in the series, 2 arose in the stomach and 1 in the small intestine. One of the gastric tumors occurred in a 24 year old female; the lesions were multiple and varied from 2 to 4 centimeters in diameter. The other occurred in a 27 year old white male; the tumor was 6 centimeters in diameter. The specimen from the small intestine, 5.5 centimeters in diameter, was obtained from a 22 year old colored male.

LYMPHOMAS

A detailed consideration of the instances of involvement of the gastrointestinal tract by tumors of the hematopoietic system will be incorporated in the general survey on lymphoid tumors. For the purposes of this study it suffices to note that 22 tumors belonging to this group were coded. Five tumors of the group were seen in persons under 21 years of age, 14 in those between 21 and 30, and 3 between 31 and 38 years of age. Sixteen of the lymphomas were classified as lymphosarcoma, 4 as reticulum cell sarcoma, and 1 each as leucemia and Hodgkin's disease. They were distributed anatomically as follows: lymphosarcoma and reticulum cell sarcoma—4 in the stomach, 6 in the small intestine, 1 in the appendix, and 4 in the large intestine. There

were 5 instances of multiple tumors. The granuloma of Hodgkin's disease was in the small intestine and the leucemic lesion was in the stomach. There were 10 known fatalities among the 20 cases of reticulum cell sarcoma and lymphosarcoma, and another in the case of leucemia. Follow-up records in the case of Hodgkin's disease were incomplete. Five of the lymphoid tumors were seen in individuals under 21 years of age, 14 in those between 21 and 30, and 3 in those between 31 and 38.

MISCELLANEOUS

Among the less common tumors in this survey there were 7 malignant melanomas, 6 of them metastatic in origin; only 1 was believed to have arisen in the ileum. Four neurofibromas were located in the appendix and were discovered at operation for what appeared clinically to be acute appendicitis. One ganglioneuroma of the cecum occurred; it measured 6 centimeters in diameter. In the 1 instance of hemangioma recorded, the lesions were multiple and were located in the ileum. One unusual gastric tumor was a hemangiopericytoma; others were hamartoma of the stomach and undifferentiated sarcoma of the jejunum. Lipoma, myxoma, lymphangioma, teratoid and other tumors, sometimes reported to occur in the gastrointestinal tract, were not observed in this series. The reason for this probably lies in the screening system previously described.

There were 8 cysts of the gastrointestinal tract, 4 related to the esophagus and 4 to the small intestine. Three of those in the esophagus were lined by respiratory epithelium and 1 by epidermis. Of the 4 in the small intestine, 1 was a parasitic cyst due to ankylostomiasis; the other 3 were enteric cysts, lined by columnar epithelium. One mucocele was seen in the rectum; it was associated with a polyp. Of interest, too, was a case of pneumatosis cystoides intestinalis for which a segment of ileum was resected. The patient was subsequently found to have a duodenal ulcer from which gas escaped into the tissues. Three cases of endometriosis were reveiwed; 2 of the lesions were in the appendix and the other in the ileum.

SUMMARY AND CONCLUSIONS

A general survey of the tumors arising in the gastrointestinal tracts of members of the armed forces between 18 and 38 years of age has been made. The results of this survey as to relative frequency and anatomic distribution is largely summarized in the accompanying tables and charts. These overall figures follow those of previous reports. The most salient features brought out are these:

1. Carcinomas of the large intestine and rectum constituted over three-fourths of all of the carcinomas of the gastrointestinal tract.

2. Carcinomas were most frequent in the older age group but mortality was relatively higher in the younger age group.

3. Polypoid lesions of the intestinal tract were observed most commonly in the rectum. No recurrences resulted after local excision.

4. Carcinoids occurred most frequently in the appendix, but those in the rectum were commonly confused with carcinomas.

5. The most frequent tumor of the lymphoma group was the benign lymphoid polyp. These tumors were commonly found in the rectum and local excision was followed by no subsequent evidences of recurrence or transformation into the malignant types.

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STREPTOMYCIN THERAPY IN URINARY TRACT INFECTIONS

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DATA on 465 patients with urinary tract infections in United States Army hospitals receiving streptomycin therapy have been assembled and submitted to critical analysis. The results of this study are presented in this communication.

Urinary tract infections constitute a serious problem in Army hospitals. The reasons for this are manifold:

1. The number of patients with paraplegia in whom ascending urinary infection is a constant threat and a serious complication.

2. Infections in patients with wounds or injuries involving the urinary system, including perforations of the bladder, cicatricial deformities of the ureters, and injuries to the genitalia and kidneys. In this group of patients cystotomies and instrumentations have resulted in, or were followed by, stubborn and unyielding infections.

3. Infections in otherwise healthy individuals due to the usual causes of stasis and obstruction.

4. Infections superimposed upon new growths.

5. The fact that no specific agent has been available hitherto for infections due to Pseudomonas aeruginosa and Streptococcus fecalis.

6. The inconstant responses, with drug-fastness frequently ensuing, in many cases of gram-negative bacillary pyuria treated with sulfonamides.

Penicillin is of no value in the treatment of infections due to gram-negative bacilli. Older drugs, such as mandelic acid have well known limitations. The need of a potent drug which is effective against bacteria causal of infection in the urinary tract is only too well appreciated.

This project was carried out as a part of the study being made under the direction of the Army Medical Research and Development Board, Office of The Surgeon General.

From the Surgical Research Unit, Brooke General Hospital.

Early reports (7) and our own observations (6) indicated that streptomycin has a potent *in vitro* action on many gram-negative as well as gram-positive bacteria including the acid-fast bacilli. Among these are Pseudomonas aeruginosa, and Streptococcus fecalis, usually refractory to other drugs. We demonstrated (6) that doses of 0.4 gram of streptomycin administered intramuscularly every 4 hours produces levels in excess of 1 milligram (1000 units) of the drug per cubic centimeter of urine and maintains a blood serum level of 16 micrograms (units) per cubic centimeter. These levels are in excess of the amount of antibiotic required to inhibit the growth of 87 per cent of the bacteria usually recovered from infected urine. A preliminary report of the effect of streptomycin therapy in infections of the urinary tract has already been published (5).

RESULTS OF THERAPY

1. Criteria. The results of treatment with streptomycin have been catalogued according to (1) clinical response, and (2) bacteriological result. The evaluation of clinical response is based on changes in symptoms and fever, and the gross and microscopic alterations of the urine. Those patients obtaining complete relief of symptoms and repeated sterile urine cultures are considered "cured." Those with remission of symptoms in whom the urine was grossly cleared, but with cultures remaining positive, are classed as "improved," while those with continuing pyuria and no symptomatic relief constitute "failures."

In classifying the *bacteriological results*, a "cure" signifies sterile urine cultures for the period of observation (usually 2 weeks after cessation of therapy), while a "failure" denotes a urine culture which continues to show pathogenic bacteria. In some instances sterile urine cultures were obtained within 24 to 72 hours after the institution of therapy, but sub-

sequent cultures were positive. Responses of this type are classified as "failures."

2. Results. In summarizing the overall results of therapy in the group of 465 cases, clinical and bacteriological "cures" were obtained in 34 per cent of the patients. In an additional 21 per cent, clinical improvement resulted, but the urines did not become sterile. Outright clinical failures occurred in 45 per cent of the 465 cases.

ANALYSIS OF RESULTS OF THERAPY

The failure to obtain any beneficial results in 45 per cent of the patients treated stimulated an inquiry into the causes of failure, to determine if the cure rate could be improved in patients treated in the future. The effects of streptomycin therapy were catalogued on the following points: (1) bacterial flora, (2) monobacterial versus polybacterial infections, (3) obstruction of urinary flow, and presence of unsterilizable foci, (4) bladder paresis, as in paraplegia, (5) clinical diagnosis, (6) dosage, (7) duration of therapy, and (8) presence of resistant organisms. The analysis will now be presented in this order.

1. Bacterial flora. The bacterial flora of the urinary tract infections comprising this series is shown in Table I. Eight hundred twenty-eight organisms representing 9 different *species*, and a group of unidentified gram-negative bacilli, are listed. Seventy-nine per cent of the total number are gram-negative bacilli. The remaining 21 per cent are gram-positive cocci, one-third of which are the penicillin-resistant and sulfonamide indifferent nonhemolytic streptococci. It is reiterated that a substantial majority of these bacteria are inhibited by concentrations of streptomycin which are easily maintained in the blood and urine by parenteral administration of the drug. Excluded, of course, are those bacteria which have acquired irreversible drug-fastness, a constant feature of unsuccessful streptomycin therapy.

2. Monobacterial versus polybacterial infections. One hundred eighty-six patients (40%) had monobacterial infections, while in the remaining 279 (60%), the infection was polybacterial.

The outcome of streptomycin therapy in the 186 monobacterial infections is summarized in Table II, according to causal organisms. The most gratifying results were obtained in infections due to Escherichia coli, paracolon bacilli, and Aerobacter aerogenes. Fewer cures followed the use of streptomycin in infections due to other organisms. The results in infections caused by Klebsiella pneumoniae, Pseudomonas aeruginosa, and Staphylococcus aureus are disappointing.

A comparison of the therapeutic effects obtained in monobacterial and polybacterial infections shows no appreciable difference between the 2 groups in the clinical results obtained. The greatest difference appears in the bacteriological results. Here it is noted that positive cultures persisted 16 per cent more frequently in the polybacterial than in the monobacterial group. This difference is statistically significant (1).

3. Obstruction of urinary flow and presence of unsterilizable foci. In an analysis of the results of therapy in patients with and without urinary calculi, the contrast in the favorable results obtained in the noncalculus group with the unfavorable results obtained in infections complicated by calculi makes it clear that failures are an almost constant feature in the latter type of case. Needless to say, these figures are statistically significant (1). Accordingly, streptomycin therapy should be withheld in the management of patients with symptomatic obstructive calculi until such time as the drug can be employed as part of the regimen aimed at removing the obstruction. Excepted of course are patients with actual bloodstream invasion, when the drug may be required as a life-saving measure.

4. Bladder paresis. All paraplegias have some degree of nervous dysfunction of the bladder, which is ordinarily designated as "cord bladder." The usual features are a weak detrussor action and an incompetent sphincter. These patients have urinary stasis as well as urethrovesical and vesicoureteral reflux.

Forty-two per cent of the patients in this series were paraplegics. In a comparison of the results obtained from streptomycin therapy in paraplegic patients and in nonparaplegic patients, no striking difference in the clinical cure rate was observed. However, a

statistically significant greater number of bacteriological cures occurs in nonparaplegic patients. As observed earlier by Petroff and Lucas, many paraplegic patients are temporarily benefited from streptomycin therapy, although their urinary systems are not sterilized, and the effects are not necessarily permanent.

A word of explanation is warranted regarding the 25 per cent cures in paraplegics. The fact of the matter is that these cured patients are no longer paraplegics in the usual sense of the word. At the time of instituting streptomycin therapy for their urinary tract infections they were ambulatory with closed urinary systems and automatic bladders. By this means the factor of residual urine and urinary reflux is eliminated.

5. Clinical diagnosis. The results of therapy may be classified according to clinical diagnosis. (a) As expected, the best results are obtained with streptomycin therapy in uncomplicated cystitis, pyelitis, and pyelonephritis. (b) It is unfortunate that the presence of calculi, in association with these conditions, sharply increases the failure rate, since here there is an urgent need for effective chemotherapy. (c) The presence of inadequately draining abscesses and fistulous tracts increases the percentage of failures. (d) When the lesions have progressed to the stage of hydropyonephrosis the chances of cure diminish significantly. (e) As noted in the 4 cases of neoplasm of the bladder, abnormal cellular growths are nonsterilizable. (f) We have shown repeatedly (4, 6) that streptomycin does not reach the prostatic secretions in therapeutic levels following parenteral administration of the drug. This is borne out in analysis of the cases of urinary tract infections complicated by lesions in the prostate and seminal vesicles, which have a high failure rate.

The *duration of the infection* has little bearing on the outcome of treatment. However, the reversal of urinary tract pathology in deep seated infections proceeds at a slow pace, and a somewhat extended course of treatment may be necessary to achieve and maintain sterile urine cultures. This fact is illustrated by the

TABLE I.—BACTERIOLOGY OF 465 URINARY TRACT INFECTIONS

Organism	Frequency Cases	Per cent
Aerobacter aerogenes	172	37
Escherichia coli	142	30.5
Escherichia coli var. ("paracolon")	17	3.7
Klebsiella pneumoniae	29	6.2
Proteus vulgaris	121	26.0
Pseudomonas aeruginosa	81	17.4
Unidentified gram-negative bacilli	92	19.8
Staphylococcus aureus	80	17.2
Streptococcus beta hemolytic	34	7.3
Streptococcus nonhemolyticus*	60	12.9
	828	

*Includes Streptococcus viridans.

TABLE II.—RESULTS IN MONOBACTERIAL INFECTIONS

Organism	Cases	Clinical						Bacteriological			
		Cured		Improved		Unimproved		Cured		Positive Cultures	
		No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
A. aerogenes	50	23	46.0	3	6.0	24	48.0	25	50.0	25	50.0
Escherichia coli and Escherichia coli variant	57	32	56.1	9	15.8	16	28.1	32	56.1	25	43.9
Klebsiella pneumoniae	11	2	18.2	5	45.4	4	36.4	2	18.2	9	81.8
Proteus vulgaris	21	8	38.1	4	19.0	9	42.9	8	38.1	13	61.9
Pseudomonas aeruginosa	17	5	29.4	3	17.6	9	53.0	5	29.4	12	70.6
Unidentified gram negative bacilli	6	3	50.0	1	16.7	2	33.3	3	50.0	3	50.0
Other gram negative bacilli	6	3	50.0	1	16.7	2	33.3	3	50.0	2	50.0
Staphylococcus aureus	16	4	25.0	4	25.0	8	50.0	4	25.0	12	75.0
Nonhemolytic streptococcus	2	0	0	0	0	2	100.0	0	0	2	100.0

results in 8 cases of severe interstitial cystitis. In each case a 10 day course of streptomycin failed to sterilize the urine but sterile cultures resulted from an additional 10 day course. It is of interest that drug-fastness did not develop in these cases. For deep seated infections it may be desirable to extend the course of streptomycin from 10 to 14 days.

Results are uniformly poor in cases with impaired renal function, since renal decompensation is attended by the accumulation of high concentrations of streptomycin in the blood and poor excretion, with low concentrations in the urine (6).

6. Dosage. It is our conclusion that 1 to 2 grams of streptomycin per day administered parenterally in divided doses is adequate for therapy of most infections of the urinary tract. Larger doses improve the rate of cure in only selected cases.

Eight patients were treated by the local instillation of streptomycin solution through urethral or ureteral catheters. All patients treated in this manner were outright failures.

7. Duration of treatment. (a) The importance of duration of treatment was studied by dividing the 465 cases into 3 categories, namely, 1 to 5 days, 5 to 10 days, greater than 10 days. No beneficial results could be shown following continuation of therapy beyond 5 days. We have observed in our own cases that 3 days of therapy is sufficient for the average case.

(b) To emphasize the importance of using streptomycin only under optimum conditions, the results in patients receiving more than one *course* of therapy were studied. Of 57 patients receiving 2 or more courses of streptomycin, failure resulted in 48 (84.2%) and cure in 9 (15.8%). Three of the 9 cures were the aforementioned cases of interstitial cystitis. In 3 other patients, stones had been removed between courses of treatment. Of the remaining 3, 1 cure was obtained by giving streptomycin in combination with sulfathiazole during the second course, while the 2 remaining cases were in paraplegics infected with another organism at the time streptomycin was resumed. We conclude, that, for the ordinary case, additional courses of streptomycin will not better the results obtained with the first course. Furthermore, the bacteria in the 48 cases, in which infection persisted developed marked drug-fastness and these patients are permanently eliminated from any hope of improvement from future streptomycin therapy.

8. Sensitivity of the bacteria. Seventy monobacterial infections, in which the susceptibility of the causative organisms by a uniform technique was available, were analyzed. The causal organisms were divided according to susceptibility or resistence to a concentration of 16 micrograms of streptomycin per cubic centimeter.

The organisms susceptible to 16 micrograms per cubic centimeter were eliminated in 52 per cent of the cases, while those indifferent to 16 micrograms per cubic centimeter were eliminated in only 22 per cent of the cases. This difference is statistically significant.

The susceptibility of bacteria to streptomycin is controlled by three factors: (1) the particular species of bacteria, (2) *p*H of the medium, (3) concentration of the drug.

The first of these we cannot change or influence. The concentration of the drug can be controlled by dosage. The *p*H of the urine can be favorably altered by alkalinization and the effect is surprisingly great. *In vitro* tests have shown that by raising the *p*H from the acid to the alkaline side, the susceptibility of an organism may be greatly enhanced (Table III).

The danger of stone formation by Bacillus proteus in alkaline urines is fully realized. However, greater efficacy of streptomycin in alkaline media should be kept in mind and employed in appropriate cases.

DRUG TOXICITY

Reactions occurred in approximately 20 per cent of the cases studied. These reactions, most of which were mild and transitory in nature, consisted principally of headache, pyrexia, arthralgia, circumoral anesthesia, and skin manifestations. In only 3 cases were the reactions severe enough to require cessation of therapy. Two of these were severe histamine-like reactions and the other was a hyperpyrexia, with severe cephalalgia, and nausea and vomiting.

TABLE III.—*p*H AND STREPTOMYCIN IN FOOD DRUG ADMINISTRATION BROTH

	*p*H 5 μgm./c.c.	*p*H 6 μgm./c.c.	*p*H 7 μgm./c.c.	*p*H 8 μgm./c.c.
Klebsiella pneumoniae	128	16	2	2
Pseudomonas aeruginosa	256	128	32	8
Bacillus proteus	128	32	16	4
Staphylococcus "SM"	32	8	4	1
Nonhemolytic streptococcus	128	64	8	4

DISCUSSION

In crystallizing the data just presented, successful therapy of infections of the urinary tract with streptomycin resolves itself into a simple formula. The requisites of successful therapy are: (1) the organisms must be sensitive *in vitro;* (2) the drug must be given in doses of at least 1 gram per day; (3) there must be an unobstructed flow of urine and at the same time pus must be drained.

To test the validity of this formula, 119 of the 161 cases in which cure followed streptomycin therapy were re-examined. Data were complete on 105 of these cases. All but 5 met the 3 criteria.

In rechecking the failures it was noted that (1) inadequate dosage was incriminated in 44 cases; (2) urinary obstruction or stasis was present in 156; while in 101 instances persistence of infection was due to the presence of one or more drug-fast bacteria.

These findings emphasize the importance of close liaison with the laboratory, careful check of the patient, and administration of streptomycin in amounts of 1 gram or more for the best therapeutic results.

CONCLUSIONS

1. Critical analysis and study have been made of 465 cases of infection of the urinary tract in which patients were treated with streptomycin. Thirty-four per cent of the patients were cured; an additional 21 per cent improved, while the remaining 45 per cent were not benefited.

2. Seventy-nine per cent of bacteria isolated were gram-negative bacilli; and 21 per cent were gram-positive cocci, a third of them nonhemolytic streptococci.

3. Streptomycin has a potent *in vitro* action on 87 per cent of the bacterial flora encountered.

4. Streptomycin parenterally administered is excreted in high concentrations in the urine, and intramuscular injection is the preferred route.

5. Best results are obtained when infections are due to Escherichia coli and Aerobater aerogenes. Failures are especially frequent when the causal organism is Pseudomonas aeruginosa.

6. There is no appreciable difference in results of therapy in monobacterial and polybacterial infections, provided of course, that all organisms are susceptible *in vitro* to streptomycin.

7. Presence of obstructive calculi precludes a successful chemotherapeutic result.

8. Patients with paraplegia are benefited by streptomycin therapy, although the effects are rarely permanent except in patients with closed urinary systems and automatic bladders.

9. Advanced renal pathology, undrained abscesses, presence of neoplasms, and infections in the prostate, are causes of failure of streptomycin therapy.

10. A total dosage of 1 to 2 grams of streptomycin per day for 3 to 5 days is recommended for treatment of the average infection of the urinary tract due to susceptible organisms.

11. No advantage accrues from the administration of a second course of the drug if the first course has failed to sterilize the urine.

12. Drug-fastness is a constant feature in cases in which the prescribed course of therapy has not sterilized the urine.

13. When bacteria are not inhibited *in vitro* by a concentration of 16 micrograms per cubic centimeter, the chances of eliminating them by streptomycin are not good. This suggests that streptomycin acts primarily through the tissues, not the urine.

14. Local instillations of streptomycin have proved to be of no value in our experience.

15. Alkalinization of the urine with streptomycin therapy may be advantageous in selected cases.

16. There is no contraindication to the concurrent use of penicillin or sulfonamides with

streptomycin if warranted by the clinical and laboratory findings.

17. The percentage of satisfactory results is highest when the requirements of (1) free flow of urine, (2) susceptible organisms, and (3) adequate dosage of the drug are met. (4) Due consideration is given to the management of the patient as a whole.

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AMINO ACIDS AND HYDROLYZED PROTEIN

PROTEIN deficiencies in the surgical patient are now recognized as of great clinical importance. Because of this, a variety of methods has been developed for the administration of protein, in addition to the usual normal method by which protein is ingested in the food. For example, the therapeutic value of blood transfusions resides largely in their protein content which, of course, occurs in at least two forms: (1) as hemoglobin within the red blood cells, and (2) as the various plasma protein fractions, particularly albumin. Plasma albumin, because of its large molecular size, exerts an important function in holding fluid within the capillary lumen, and substitutes for it must possess a similar colloidal property. Transfusions of blood and plasma are primarily useful for the immediate prevention or correction of acute deficits following loss of blood or plasma in a variety of surgical patients.

Protein deficiency of nutritional origin presents a different problem. This type of deficiency primarily follows protein deprivation in the diet, and is aggravated by any condition which produces an increased loss of protein tissue. When these patients are unable to ingest and assimilate protein by mouth, the correction or prevention of protein deficiency is found to be impossible unless there is some method available for the introduction of this essential element through the parenteral channel.

Under normal conditions, protein is utilized only after digestion, during which process the large protein molecules are broken down to smaller building stones, including both single amino acids and small combinations of them, usually called peptides. After absorption into the blood stream, these amino acids and peptides are carried throughout the body to be manufactured into tissue proteins, plasma proteins, hormones, enzymes, etc., each of which has its own characteristic amino acid composition. Should the parenteral channel be required it seems clear that a similar process should be devised. Normal protein nutrition can be maintained only by the assimilation of an appropriate mixture of amino acids, whether it originates from food protein or from protein digests supplied as such either by mouth or by injection.

Amino acid mixtures are available for intravenous injection, and they are widely employed therapeutically to supply parenteral protein food. Strictly speaking, the term amino acid mixtures should be limited to the pure crystals dissolved in water; this method is impractical at the present time because of its cost. Similar mixtures as now used may or

may not include smaller peptides and are made by the digestion or hydrolysis of appropriate proteins which are then purified so as to make them safe for parenteral use. They go by various trade names, but are really solutions of hydrolyzed or digested protein. It must be emphasized that such solutions contain small molecules which possess none of the physiological properties of the large protein molecules mentioned above. They can serve only as a source for the manufacture of protein or for the nutrition of tissues requiring them. Amino acid mixtures or solutions of hydrolyzed protein cannot, therefore, be classed as blood substitutes, but merely as substitutes for the building stones of protein which normally originate in the gastrointestinal tract. However, solutions of hydrolyzed protein may be made in which the process of hydrolysis is much less complete, so that much larger amino acid residues are present, including particles which may even be large enough to act as colloids. Such preparations represent a meeting ground between amino acids and proteins. Some attempts have been made (Brinkman[1]) to provide a protein hydrolysate which not only contains the building stones of protein, which will act as a source of parenteral protein nutrition, but which also contains sufficiently large particles to act as a substitute for the albumin in the circulating plasma.

To be effective nutritionally, such solutions must contain all of the essential amino acids required for normal physiological function. Whether small peptides are an advantage or not has aroused considerable interest, but cannot be answered finally. At least one peptide, the so-called strepogenin described by Woolley,[2] seems to be essential for growth and cannot be synthesized by the body from amino acids. How important it is in the maintenance of normal protein nutrition awaits further study.

Harmful reactions following the injection of hydrolyzed protein have been observed just as they have following plasma and whole blood transfusions. Any complex mixture introduced into the circulation must be prepared and given with great care and only when indicated in order to minimize such reactions. At the present time adequate preparations of hydrolyzed proteins have been extensively employed and careful study has shown that they are probably as safe or safer than plasma or whole blood transfusions. They have proved their value as a source of protein nutrition in patients who are unable, temporarily, to take any protein or an insufficient amount of protein by mouth. As long as surgeons are confronted with the patient who cannot take and assimilate adequate protein nourishment through the gastrointestinal tract, the parenteral injection of appropriate amino acid mixtures is the only physiological method of preventing or correcting protein starvation during such periods.

ROBERT ELMAN.

[1] Brinkman, R., et al. J. Lab. & Clin. Med., 1945, 30:1034.
[2] Woolley, D. W. J. Biol. Chem., 1946, 162:382.

GELATIN AS A PLASMA SUBSTITUTE

THE search for an effective plasma substitute during the last war led to a reinvestigation of the possible usefulness of gelatin solutions. Several groups of investigators studied different gelatins including those derived from fish isinglass, animal hides, and beef bone. Although favorable reports appeared concerning each of these preparations, the one which was assigned optimal rating by the National Research Council, after a physicochemical and biological survey of the field, was bone (ossein) gelatin of the Knox P-20 type. This preparation

comes from the manufacturer in a pyrogen-free physiological saline solution, in a sealed container ready for use. It has been administered to many hundreds of patients, as well as to large numbers of animals, and gives promise of being a valuable plasma substitute as far as its use in restoration and maintenance of plasma volume is concerned.

In physicochemical properties gelatin differs in several respects from natural plasma protein. Whereas the plasma proteins may be grouped into a few classes of molecules, each of uniform size and shape, gelatin comprises a broad spectrum of molecular sizes, each having a diameter of about one-half that of the plasma proteins, but varying greatly in length. The shorter molecules readily permeate biological membranes, but the longer ones are retained. Solutions of gelatin which have been least degraded through cooking or autoclaving will contain larger proportions of very long molecules; these preparations tend also to have a higher viscosity and will "gel" at room temperature. However, they enjoy a considerable physiological advantage in shock therapy over the more degraded, less viscous preparations, because the long asymmetrical molecules tend to be retained longer within the circulation, maintain plasma volume longer, and are more efficiently metabolized.

A 6 per cent solution of Knox P-20 gelatin possesses a colloid osmotic pressure approximately 50 per cent greater than that of plasma. Therefore, when administered to normal subjects it tends to cause a transient hemodilution by pulling in water from the tissues. Its hemodiluting effect is approximately equivalent, gram for gram, with human serum albumin. However, unlike albumin the smaller and more oncotically active molecules of gelatin are rapidly excreted through the kidney, so that the hemodiluting effect may not be as long maintained as with albumin. This difference does not appear to be of great practical importance in therapy of hemorrhagic shock, because an animal or patient who, although in shock, is not suffering from prolonged depletion of protein stores, appears to mobilize new plasma protein with sufficient rapidity to compensate for the gelatin excreted. Comparative studies have shown gelatin to be at least as effective as plasma in restoring circulation after severe hemorrhage, with or without prolonged hypotensive periods, and it has been employed in the shock phase of severe burns with excellent results. However, it must be emphasized that *neither plasma nor gelatin is more than a temporary and partial substitute for whole-blood replacement in shock due to blood loss.*

Gelatin which has been properly prepared is nonpyrogenic and nonantigenic—the incidence of reactions following its administration to patients has appeared to be substantially lower in practice than with plasma. Unlike acacia, pectin, and other large molecular carbohydrates which have been employed as infusion colloids, gelatin does not accumulate in the liver and other organs, and no histopathological changes appear following the administration of large amounts over prolonged periods. Furthermore, gelatin may be given without fear of transmitting the virus of homologous serum jaundice which may be present in blood and plasma. It may be kept for long periods of time without refrigeration, and can therefore be readily available for emergency use in accident wards, physicians' kits, and catastrophe depots. It also has the great advantage of low cost, the cost being less than 10 per cent of that of commercial human plasma.

However, there are some disadvantages of gelatin which should be pointed out. In the first place, the most suitable preparations are those which will gel after standing at room

temperatures for a few hours, and more rapidly at colder temperatures. This makes it necessary to place the flask of gelatin in hot water for ten or fifteen minutes just before starting the infusion, unless the material has been previously kept in a warm cabinet. Some difficulty would be encountered in using this type of gelatin under any conditions where the environmental temperature is below 65 degrees F., but in ordinary hospital practice gelation is not a troublesome problem.

Another shortcoming of gelatin is its relatively low nutritive value, it being deficient in at least four of the amino acids essential for the composition of a "complete" protein. There is evidence that gelatin may be utilized as protein in the body economy if given in conjunction with other complete proteins, but for meeting the nutritional requirements of surgical patients, gelatin is not equivalent to plasma, whole blood, or intravenous protein hydrolysates. It seems possible that this limitation of gelatin might be overcome by adding to it sufficient amounts of the amino acids in which it is deficient, but this has not yet been accomplished on a commercially practical basis.

A minor troublesome property of gelatin is its tendency to cause erythrocyte rouleaux formation ("pseudo-agglutination") with a consequent accelerating effect on the sedimentation rate. There is no evidence that intravascular rouleaux formation is of any physiological consequence, and the only respect in which it becomes of importance is in the interpretation of blood grouping and cross-matching reactions of patients whose blood contains gelatin. It has been pointed out that the microscopic appearance of the rouleaux is markedly different from that of agglutinated erythrocytes, but the technician who is not trained to recognize the difference may experience difficulty in making the correct interpretation. Fortunately, the production of rouleaux is inhibited in the presence of 1 per cent glycine, and a technique has been described for eliminating pseudoagglutination as a source of confusion.

The distribution and clinical use of gelatin has thus far been limited because of the availability of large quantities of surplus Red Cross plasma, and because of the recent emphasis on the need for whole blood in the replacement therapy of hemorrhagic shock and burns. However, gelatin has earned a useful position as a substitute for plasma under conditions where maintenance of plasma volume is the principal requirement, and it should find important future applications in civil and military surgery, particularly under conditions where plasma is not readily available. After gelatin has been used to maintain circulatory dynamics in accidental or operative trauma, or burns, any significant deficit of red cell mass should be compensated by transfusions of whole blood, just as is required with plasma itself.

JOHN S. LOCKWOOD.

THE SURGEON'S LIBRARY

THE BOOK SHELF

DISCOVERY PAINS

ESTHER H. VINCENT Evanston, Illinois

IN contemplating the adventures of Christopher Columbus, we experience all the delightful thrills of patriotism, mystery stories and bingo. As children we bounced our balls to the rhythm of

> "Columbus sailed the ocean blue
> In the year of fourteen-ninety-two"!

And, as grown-ups, we find in these lines just about all we can be sure of in connection with the Admiral of the Ocean Sea. Like the discovery of anesthesia, the discovery of America may be said to have a three or four way stretch. Columbus must share honors with Vikings, French fishermen, and possible other early navigators who were afflicted with secrecy. That the 1492 voyage was not Columbus's first Caribbean tour has been suspected. Doubts as to the virginity of his experience as a discoverer have arisen, but, since publicity determines fame, the 1492 escapade is the one that counts.

According to the chroniclers, our hero was born anywhere from 1436 to 1451. That he was a native of Genoa is a moot point. He said he came from there, and in a codicil to his will, he left a sum of money for the building and endowment of a Genoese hospital for the poor. Nevertheless, he was never known to speak or write Italian, and of the 124 Colombos living in Genoa in the fifteenth century, not a single family claimed relationship with the great discoverer. He seems deliberately to have veiled his early life, and even disguised his name in a cabalistic signature of which nothing but "Christ Bearer" can be made out. So, when we gaze reverently at the urchins playing about the doorway of number 37, Vico dritto del Ponticello, Genoa, we cannot be too sure of visualizing little Cristoforo.

Present-day tales of Columbus trace their descent from his own notes and diaries, and from the biographies of Ferdinand Columbus, his natural son, and of Bartolomé de Las Casas, first priest ordained in the New World. These records, however, are as misty and windy as the sea over which the Santa Maria sailed. The Admiral himself apparently had acquired the habit of mixing facts with wishful thinking, certainties with expectations. It was not until the eighteenth century that the lamp of fame illuminated the Columbian legend. By that time it was difficult to tell the false from the true, the forged from the original, the fairy tales from the realities.

Columbus appeared on the scene at the time when the shadow of Islam was retreating before the rising sun of royal Spanish Christianity, when the dawn of the Renaissance was beginning to dispel the gloom of the Middle Ages. Story has it that he was the son of a Genoese weaver of substantial means, that he was the eldest of a family of three sons and one daughter, that he had blue-gray eyes and reddish hair (early becoming gray), a hawk nose, a thin, straight mouth, and a tall, muscular, well-proportioned figure. He is supposed to have attended the University of Pavia, to have been trained as a weaver, and to have had some sailing experience, possibly sprinkled with a dash of piracy. He may have reached England and there are rumors of Iceland. It was in Lisbon that he married Felipa Moñiz Perestrello, daughter of an aristocratic Italian navigator and explorer, to whose charts and nautical instruments Columbus fell heir. It was there, too, that he is said to have entered into exciting scientific correspondence with cosmographer Toscanelli, brilliant son of a Florentine physician.

Columbus spent about ten years in Portugal, making and selling maps, studying and dreaming maps, and waving maps around in the face of John II. John was sympathetic to the waving, but his Council of Geographers was not. All that Columbus had to show for his Portuguese trials was a broken hope and his son, Diego. Finally, Felipa having died, the would-be discoverer took Diego by the hand and set out for Spain. There,

From the Archibald Church Library, Northwestern University Medical School.

finding both Ferdinand and Isabella apathetic alike to his eloquence and to his maps, Columbus found solace in the arms of Beatriz Enríquez de Harana, mother of his second son, Fernando. For the next eight years their Catholic Majesties kept poor Columbus dangling. A drop by drop account of the trickle of hopes and coins that fell into his begging-cup would discourage a Job. But the patience of Columbus was sustained by his fixed idea. At last, deciding that he was a displaced person in Spain, he started out to invade France. Every school-child knows the rest of the story—the romantic halt at La Rabida, the recall to Granada, the last rejection, the second recall near the bridge called Pinos, the episode of the Queen's jewels (she didn't really have to pawn them!), and the final agreement.

On August 3, 1492, three little ships sailed out from Palos with eighty-eight jittery mariners, riff-raff drummed up from the taverns of the town. The leaders, however, were experienced sea-men, the brothers Pinzon (Martin and Francisco on the Pinta, Vicente on the Nina). On March 15, 1493 two of the little ships came back to Palos, bringing gold, curios, Indians and probably syphilis. On the shores of a strange new world they had left the sea-wrecked Santa Maria and a sorry group of impromptu colonizers, who ruined both themselves and the natives. Columbus thought America was Asia and never discovered his mistake. The Indians thought the white men were gods, but soon discovered their mistake. Las Casas, dying at 92 in Madrid, left to posterity his *Historia de las Indias*, so horrifying a manuscript that Spain kept it unpublished until nearly the end of the nineteenth century. Oviedo, who as a boy saw the suppliant Columbus at Granada, spent some time on Haiti as a gold supervisor, and in his *La General y Natural Historia de las Indias*, mixed bloody and revolting tales of debauchery with his descriptions of tobacco and guaiacum.

Physical ills bothered Columbus little up to the time of his first American journey, although the strain of living on frustrated hopes must have been considerable. Probably the driving force of his fixed idea kept his body in tune with his ruling passion. However, on Voyage I, he complains of "sore eyes," a discomfort that evidently pestered him the rest of his life. It has been suggested that this ophthalmia may have been trachoma. Voyage II, the "Gold Rush" of '93, started on September 24, and was full of misery. Two days out, Columbus fell victim to a strange malady. "It cast him into a dangerous disease between a pestilential fever and lethargy, which deprived him of sense and memory." He was in a stupor at times, and thought himself at the point of death. This may have been typhus or typhoid or even brucellosis, but it could have been due to febrile attacks of secondary syphilis, clinically more severe in those days than now. In a couple of weeks he felt better, but had recurrent attacks over a period of some months. Dr. Garcia Fernandez, ship's surgeon on the first voyage, reports jail fever among the crew, later supplanted by "tropic fever." But Dr. Alvarez Chanca, physician on the second voyage, reports that at times one third of the men were suffering from some unknown disease called "the scourge." It was during the period between these two voyages that syphilis first became rampant in Europe.

Primary proof of the American origin of syphilis is said to be a treatise against the "serpentine disease" (*Tractado Contra el Mal Serpentino*, Sevilla, 1539) by the Spanish surgeon, Ruiz Diaz de Isla. This author saw the first syphilitics who landed in Europe, and treated them by rubbing their sores with mercurial ointment and by administering guaiacum, the Holy Wood that grew in America and was said to be used by the Indians as an antidote to what ailed them. A phrase found in the original manuscript (1537) is omitted from the printed editions. It reads: "As it is of its very nature contagious, they got it easily; and presently it was seen in the fleet itself in a pilot of Palos who was called Pinzon and others whom the aforesaid malady kept attacking."

Now Martin Alonzo Pinzon, captain of the Pinta, had gone A W O L on the first return voyage and had stopped in Bayona in Galicia before rejoining Columbus at Palos. The hygienist, Tommaso Ragoni of Ravenna, states that the first epidemic of syphilis began in Galicia in March of 1493, and that the disease was then called Morbus Galecum. Ragoni wrote a treatise under that title which he published in Venice in 1537. Since Francisco Pinzon was heard of no more after Voyage I, he is too shadowy a figure to consider. And since Vicente Pizon kept on being a healthy explorer for many years, he probably did not contract the disease. But Martin Pinzon is said to have died shortly after his return from America, and most probably it is Martin to whom Diaz de Isla refers as the "pilot of Palos who was called Pinzon."

Both Las Casas and Oviedo agree that syphilis originated in America, but Diaz de Isla maintains that his "serpentine disease" is identical with the "lichen" of the Greeks and the kiss-spread "mentagra" of Pliny. He further states that the therapeutic action of mercury was unknown during the first fifteen years of syphilis, but later admits that

the Arabs seem to have known about it. The three types of his serpentine disease correspond roughly to the three stages of syphilis.

It seems odd that so universal a disease as syphilis could have once been confined to the island of Haiti, and that the handful of sailors who returned with Columbus from the first voyage could have contaminated the whole of Europe within eighteen months. But it is just as odd that no pre-Columbian syphilitic skull has appeared in Europe, although many have been dug up in America. Microbial evolution may account for the change in a hitherto innocuous germ, since definite variations in virulence are known to occur in bacterial transition to a strange host. Certain it is that a syphilitic tidal wave engulfed Europe in the closing years of the fifteenth century. Isolated disease descriptions by medieval writers suggest various syphilitic stages, but there seems to have been no widespread contagion prior to the return of Columbus. However, it should be noted that the close of the century marked the break-down of the so-called leprosy of the Middle Ages into a dermatologic potpourri, some of which may have been venereal. And to say that Charles VIII and his army spread the new disease as they returned from the siege of Naples in 1496 is an anachronism, for historians now agree that there was no such siege.

That the illness of Columbus on Voyage II was due to secondary syphilis is, of course, possible. But it should be noted that his trials and tribulations while visiting the newly discovered islands of the West Indies were enough to aggravate any infection. He had almost no sleep for thirty-three days, and was utterly exhausted by the terrible wear and tear of mind and body. Leaving his colonists racked by sickness and hunger, he returned to Cadiz in June of 1496.

Two years later he set out on Voyage III, and this time he is said to have been incapacitated by a "severe attack of gout, followed by a violent fever." This is the first time that he suggests any pain in his joints. That he really had gout is doubtful, for gout seldom affects so abstemious a man as Columbus. Furthermore, his illness was accompanied by a high fever and occurred for the first time during the summer months. Nor was it confined to a few of the smaller joints. Rheumatic fever has been suggested, but ordinarily rheumatic fever does not resolve into "chronic rheumatism" of the kind with which Columbus continued to be afflicted. His joint pains eventually subsided into what seems to have been chronic polyarticular arthritis. The pain and rigidity became gradually progressive and never left him. In general, the account of his malady sounds like rheumatoid arthritis, starting with an acute attack accompanied by high fever. The conditions under which he lived could very easily have furnished the predisposing and exiting causes.

In *Authentic Letters of Columbus*, translated by J. I. Rodrigues, the Admiral writes to son Diego, "The ailment which afflicts me is so bad, and the cold weather aggravates it so much, my illness prevents me writing except at night. In the daytime my hands have no strength." In rheumatoid arthritis the hands are often the first to be affected, the fingers eventually becoming gnarled and rigid.

It was during this same voyage that his companions noted the peculiar condition of Columbus's mind. On Christmas Day, 1499, he seemed strangely introverted, and spent long hours in self absorption. Of this occurrence, Columbus himself relates that he heard a voice from heaven saying, "Take courage. Be not afraid, nor fear. I will provide for all."

His return journey was made in chains. Much abuse has been heaped upon Bobadilla, newly appointed governor of the new islands, for his cruel and dishonorable treatment of Columbus, treatment that Columbus endured with dignity, but with self-conscious martyrdom, for he directed that his chains be buried with him. To be shipped back home like a common felon could have aroused sufficient emotional trauma to produce at least a few psychopathic symptoms. The reason for Bobadilla's actions may be laid to his own inferiority complex, a mass of fear, ignorance and jealousy, conflicting with Columbus's simple, infuriatingly self-righteous, and rather domineering ways. Although Columbus was a natural commander, he was no organizer, and probably had an irritating tendency to make a mess of administrative affairs.

But it is also possible that Bobadilla suspected that Columbus was insane, and simply took the usual measures of dealing with men possessed with a devil. Such men may have been merely possessed of a spirochete. On the other hand, geniuses frequently feel themselves to be inspired, and Columbus's conception of himself as the "Christ-Bearer" to the New World may have had a purely psychological basis born of implicit faith in his own great destiny and encouraged by the adulation and honors heaped upon him after Voyage I.

On the way home he wrote a long, confused letter to Doña Juana de la Torre, friend to Isabella, a letter that to some psychiatrists gives evidence of a psychotic mind. Upon arrival his chains were removed, and both he and Isabella

cried and sobbed together. In succeeding months he became absorbed in the mysticism of the Bible, and, as "Ambassador of God," importuned the Pope for another crusade to free the Holy Sepulchre from the infidels. His sense of persecution grew stronger and stronger. If this was tertiary syphilis, it would indicate a more rapid progression than usual, for it was only about eight years since the first voyage on which the primary infection may be said to have occurred. However, this would coincide with the rapid action of the spirochete in a member of a completely non-immunized group. Diagnosis is difficult, because of the chaotic mass of controversial material, but a detached historical spirit recognizes that, apart from the ophthalmia and the rheumatoid arthritis, syphilis would account for all of his symptoms, both in their nature and in the relative times of their occurrence. To explain them otherwise means considering a list of single and distinct pathological conditions, including relapsing fever, typhus or typhoid, rheumatic fever and valvular heart disease, followed by paranoia.

In the spring of 1502 Columbus began his fourth and last "farewell tour" of America. He wanted to find a strait through which he might sail west into Portuguese Asia. During most of the voyage he was too sick to leave his cabin. Cardiac dropsy added to the pains of arthritis made his life miserable enough without the hardships of exploration. Poor food and bad weather plagued his little fleet. Storms wrenched and strained his crazy, worm-eaten ships as they wandered painfully among the keys and shoals he had named the Garden of the Queen. Mutiny blazed up in his crews. Shipwreck ran him aground on Jamaica, where the Nazi-like conduct of his men started the first American Revolution. Only his ability to foretell an eclipse of the moon saved him and them from the revenge of the superstitious natives.

Arriving in Spain two years later, he was so ill that he had to be carried ashore. Meanwhile, friend Isabella had died of an intestinal tumor, untreated because she was too modest to allow herself to be examined. Her scamp of a husband, Ferdinand, always hostile, was of no help to the discoverer of Spain's new empire. Poor Columbus lived in misery attempting to follow the court on its interminable peregrinations. Unable to endure the jittery paces of the Andulusian horses, he was forced to hoist his swollen legs on mule-back or be carried in litters.

Valladolid lies in a cleft among barren, treeless mountains, a city drowsing away the hours in its silent convents and dusty streets. There, heart-sick and weary, Columbus dragged himself after the court for the last time. There he lingered painfully until May of 1506 when his diseased heart valves finally played themselves out. He handed over into the hands of God his proud, courageous spirit,

"A battered, wrecked old man,
Thrown on this savage shore, far, far from home
Pent by the sea and dark rebellious brows . . .
My terminus near,
The clouds already closing in upon me,
The voyage balk'd, the course disputed, lost,
I yield my ships to Thee . . ."

Walt Whitman.

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REVIEWS OF NEW BOOKS

BECAUSE the author of *Postgraduate Obstetrics*[1] has had extensive experience as a teacher of postgraduate courses, this book is distinctly authoritative. He has attempted to discuss only subjects which should be of interest to the average family doctor based on the statistical frequency of obstetric complications.

The chapter dealing with the toxemias of pregnancy is admirably presented and it emphasizes the conservative attitude of nearly all obstetricians as regards the treatment of eclampsia. However, one does not agree with the author's statement that "it is justifiable to state didactically that *eclampsia represents a contraindication to cesarean section*" (author's italics). In rare instances a cesarean section under direct infiltration anesthesia is justifiable in the presence of eclampsia.

In the section on the acute infectious diseases, such unusual diseases in pregnancy as small pox, scarlet fever, measles, and malaria are discussed. German measles, which is important because of its harmful effects on the fetus *in utero* when it occurs during the first three months of gestation, is omitted. One has less faith than Mengert in cystography as an aid in the diagnosis of placenta previa. Many believe that the Braxton Hicks version which is described as one form of treatment of placenta previa should be given up entirely because it is a dangerous procedure even for specialists. On the other hand, contrary to the author, one believes that a cesarean section is indicated in all cases of total placenta previa, even if the baby is not viable or is dead, so as to prevent maternal death or injury.

One agrees that premature artificial rupture of the membranes represents the safest method of induction of labor provided the proper conditions are present but it is doubtful that when pituitary extract is used for induction as much as 6 minims can be used as one dose with impunity. Rupture of the uterus has followed even 1 minim doses given for induction of labor. In the section dealing with uterine inertia, Mengert properly warns that the use of more than 2 minim doses imposes intolerable maternal and fetal risks. In the discussion on postpartum hemorrhage, one believes two recommendations should be omitted, namely the use of the Credé maneuver even if bleeding is not checked by oxytocic drugs and the use of intrauterine douches. There may be a question as to whether it is proper in a book on postgraduate obstetrics to include a detailed chapter on sterility including the matters of adoption of a baby and artificial insemination. Minor criticisms are the frequent use of the word "pituitrin," a trade-name, instead of the term "posterior pituitary extract" and the secondary position (in parenthesis) assigned to the metric system. The use of the metric system in dealing with medical subjects conforms with practically all foreign medical literature and many representative American journals.

In spite of suggested differences of opinion, this book is a valuable contribution. It covers all the obstetric subjects with which general practitioners must be familiar, it is well written by one of the foremost obstetricians, it contains sound, practical advice and it has numerous instructive illustrations, most of which are beautiful drawings by Ruth Maxwell Sanders. The book has been printed on paper of good quality, the type is clear, and the illustrations have been well reproduced.

J. P. GREENHILL.

[1] POSTGRADUATE OBSTETRICS. By William F. Mengert, M.D. New York and London: Paul B. Hoeber, Inc., 1947.

THE monograph, *Penicillin in Neurology*,[2] devotes approximately one-half of its text to basic studies describing the dispersion and absorption of penicillin when injected intrathecally and to the effect of this drug upon normal nervous tissue. Four of ten chapters are concerned with penicillin therapy in meningitis, in infections of the skull and brain, in diseases of the spinal cord and its coverings, and in syphilis of the central nervous system. A final chapter recounts briefly the relation of antibiotics other than penicillin to the normal and diseased central nervous system. Selected references, 311 in total number, are appended to each chapter. The authors may be considered as authorities since they were among the first, if not the first, to report certain noxious influences of penicillin upon the intact and infected brain. These clinical observations have been followed by a series of lengthy and critical experimental investigations.

The textual material and the well chosen illustrations and charts, largely a summation of the authors' own experiences, combine to form a scholarly description of the biophysiology of penicillin. The discussions of penicillin therapy suffer only from the usual need of terminating a modern monograph at some definite publication date and from the obvious fact that antibiotic therapy is a matter of daily accruing data. This deficiency is most noticeable in the chapter devoted to streptomycin, streptothricin, actinomycin, and clavacin.

The wisdom of including a chapter upon the value of penicillin in syphilis is open to the contention that this might be evaluated more clearly by contrast to other methods of therapy detailed in a specialized text upon syphilis. Neurologists and neurosurgeons should be very content with this monograph, however, and make this edition, and future editions, mandatory reading for their students.

BARNES WOODHALL.

[2] PENICILLIN IN NEUROLOGY. By A. Earl Walker, M.D., and Herbert C. Johnson, M.D. Springfield, Illinois: Charles C. Thomas, 1946.

THE new edition of *Cardiovascular Disease*,[1] by Scherf and Boyd is a standard textbook. The authors have successfully covered a very extensive field in a single book of 455 pages. The material presented for the most part represents a conventional viewpoint of cardiology in the United States. The book is carefully printed, well organized, and satisfactorily indexed.

The chapter on myocarditis to which the authors call particular attention may cause some debate with their readers. The chapter on heart and endocrine disorders might also provoke some dissension. Particular reference might be called to the presumed effect of estrogens upon the electrocardiogram. The pages on irradiation of autonomic reflexes to and from the heart although short, is particularly interesting.

On the whole this book is to be recommended as a standard text in cardiovascular disease.

CHAUNCEY C. MAHER.

THE third edition of Greenblatt's *Office Endocrinology*[2] represents a revision and enlargement of the material presented in the first two editions. The author considers all the glands of internal secretion but the real emphasis, indeed the real value of the book, lies in its comprehensive treatment of the problems concerned in female endocrinology. The presentation is intended as a guide to the endocrine problems which the general practitioner and the gynecologist may meet in their everyday practice. It is concise in its expression and does not include a great deal of theoretical material. The emphasis is on therapy, and a section on hormonology includes a list and a discussion of many of the available estrogens, androgens, progestational hormones, adrenal cortical hormones, and pituitary hormones. There is a small section on male endocrinology. In the opinion of the reviewer this book should prove of considerable value to the general practitioner in the treatment of such endocrinopathies as amenorrhea, dysmenorrhea, menometrorrhagia, and the climacteric. There is a very good discussion of such diagnostic adjuncts as the vaginal smear, endometrial suction curettage, and the more recent pregnancy tests. The diagnostic and therapeutic principles expressed are sound and should contribute much to the understanding and treatment of endocrine problems which are always among the most complex encountered not only by the general practitioner but by the gynecologist as well.

STUART ABEL.

THE purpose in publishing at this time, *Progress in Gynecology*,[3] a 552 page volume, was "to refresh and bring up to date those medical men who have spent the last years in the armed forces of their country and who have been removed from the practice of the diseases of women."

The book is a collection of articles contributed by 71 authors, each an authority in the field of his writing. The editors are to be congratulated on their success in persuading these representative men to contribute, for the value of a volume of this type depends upon the authority with which the many authors can speak. The wide field of interest of these contributors indicates the breadth of the field of gynecology today. In addition to many gynecologists, the authorship includes internists, obstetricians, pathologists, anatomists, general surgeons, endocrinologists, a biochemist, a hematologist, a psychiatrist, a neurologist, and a geneticist.

It has been the purpose of the editors to bring out the varied points of view. For example, the section on carcinoma of the cervix includes a chapter on, "The Relation of Intraepithelial Carcinoma to Invasive Cancer of the Cervix," a chapter on, "Cancer of the Cervix; Principles of Radiation Treatment," a chapter on, "Cancer of the Cervix; Vaginal Cone Method of X-ray Irradiation," a chapter on, "The Wertheim Operation," a chapter on "Pelvic Lymphadenectomy in the Treatment of Cervical Cancer," and a chapter on "Cancer of the Cervix in Pregnancy." As a result of presenting the subject in this manner it becomes apparent that the editors are attempting to convince the reader that the subject is a living one and that many gynecologists are searching for the answer along different paths.

In addition to good sound advice on the older clinical subjects given by seasoned gynecologists, the book contains chapters on newer and more controversial subjects such as culdoscopy, various endocrinological subjects and menstrual toxin. These subjects are presented by special workers in their respective fields and perhaps their ideas indicate unjustified enthusiasm. This statement is not to be construed as a criticism, for in these chapters lie stimuli for thought that every reader should receive. Although the volume was prepared primarily for the returning medical veteran who is interested in gynecology, it can be read to great advantage by all gynecologists and obstetricians. Those gynecologists who were not in the armed forces have been so engrossed in routine teaching and practice that a refresher course such as is given in this book can be taken with profit.

R. W. TE LINDE.

THIS monograph, entitled *Ulcer of the Stomach, Duodenum and Jejunum*,[4] by Dr. Ralph C. Brown, is a book of great value for the medical student and general practitioner. The author gives a short résumé of ulcer history and a brief review of present day trends in ulcer treatment. His x-ray film contours are interesting and instructive. The

[1] CARDIOVASCULAR DISEASE. By David Scherf, M.D., F.A.C.P., and Linn J. Boyd, M.D., F.A.C.P. Philadelphia, London, Montreal: J. B. Lippincott Co., 1947.

[2] OFFICE ENDOCRINOLOGY. By Robert B. Greenblatt, M.D., C.M. 3d ed. Springfield, Illinois: Charles C. Thomas, 1947.

[3] PROGRESS IN GYNECOLOGY. Edited by Joe V. Meigs, M.D., and Somers H. Sturgis, M.D. New York: Grune and Stratton, 1946.

[4] ULCER OF THE STOMACH, DUODENUM, AND JEJUNUM. By Ralph Brown, M.D. Edited by Henry A. Christian, A.M., M.D., LL.D., Sc. D. (Hon.), F.A.C.P. (Hon), F.R.C.P. (Can.). New York: Oxford University Press, 1946.

section on diagnosis and differential diagnosis is excellent. Dr. Brown's description of the exacting treatment of ulcer that has proved its value through the years should be especially studied. In the reviewer's experience, ulcer has been treated more unscientifically than has any other condition met with in internal medicine. Ulcer is not a disease that can be neglected or slighted if it is to be cured. The excellent results obtained on Dr. Brown's service, and the few "intractable" cases requiring surgery speak well for the efficacy of his therapeutic measures. The book is concise, well organized, and outlines a management of patients with ulcer that has proved its value through the years. A. J. ATKINSON.

AFTER 5 years, Drs. Mazer and Israel have made available a second edition of *Menstrual Disorders and Sterility*.[1] The new edition is the same attractively printed and readable volume as its predecessor with revisions and additions to the clinical material from which the authors draw liberally to substantiate their text.

The treatment of the subject closely follows that of the first edition. An enlarged section on the physiology of the ovary and pituitary is followed by a group of chapters on amenorrhea, uterine bleeding, and sterility. A discussion of artificial insemination has been added, and in the informative chapter on male sterility, Dr. Charles W. Charney has introduced many excellent illustrations of testicular pathology. The appendix now contains a more complete summary of most of the available commercial endocrine preparations.

The chapter bibliographies in general will serve as comprehensive reference lists on almost every facet of the subject matter discussed. The omission of certain recent work of significance is thus thrown into rather sharp focus. One finds no mention of a possible luteotrophic factor in the section on pituitary physiology, and some investigators will not be entirely in accord with the authors' statement, in summarizing the therapy for dysfunctional flow, that, "Since neither estrogen nor progestin is capable of enhancing the pituitary-ovarian mechanism, it is difficult to rationalize such treatment." Drs. Mazer and Israel report considerable success in treating anovular menstruation with combined gonadotropins. Their reference to the work of some of the original proponents of this therapy, however, does not include more recent reports by the same authors in which the success from such treatment is seriously questioned.

The problem of sterility is handled in the last nine chapters. Empiric use of low dosage irradiation of pituitary and gonads was followed by pregnancy in 65 out of 78 barren women with amenorrhea or oligomenorrhea. Certainly success, such as this, reported by the authors in an analysis of 695 cases of sterility deserves the attention of other workers in this field.

The family physician may find that the wealth of detail presented in this volume is somewhat confusing in the clinical management of his cases, and he may regret the lack of a more critical assessment by the authors of much of the work by others quoted. This book is of more particular interest to the specialist whose experience may justify discrimination in accepting all of the therapeutic principles and procedures mentioned. SOMERS H. STURGIS.

THE book, *Adolescent Sterility*,[2] is an interesting and well written monograph which attempts to answer the question; "What, if any, interval of time normally elapses between the appearance of the first menstruation, the menarche, and the ability to conceive and carry a fetus to term?" The evidence that a period of adolescent sterility exists in most mammals and that the onset of fertility is not synchronous with reproductive maturity has been presented in a very readable manner. This text will be of most interest to investigators of problems of human fertility, anthropologists, and endocrinologists.

JOHN W. HUFFMAN.

THE highly specialized book, *A Manual of Tomography*, by Weinbren,[3] will serve well as a reference for those interested in body section radiography. Even those radiologists who have had considerable experience in the method will find it useful. The theory and the technical aspect of the method are presented briefly in Chapters I and VII. The section on theory is inadequate without supplementary reading from the references in order to obtain a full understanding of the method, but the section on technique will serve well as a guide for the technician.

The chapters on the clinical application of the method present rather fully the findings in most of the conditions in which tomography is a useful aid in diagnosis. The superiority of the method in the demonstration or appraisal of many lesions is well illustrated by the comparison of the body section roentgenogram with the conventional roentgenogram of the same region.

The text is elaborately illustrated with 391 reproductions of x-ray films on its 267 pages. These roentgenographic illustrations unfortunately have been printed in the positive (black and white reversed from the original) and for this reason frequently fail to bring out details which are discussed in the text and which were evidently present in the author's original roentgenographic film. A bibliography of some 69 references is included and the index is adequate.

The book has been well printed on a good quality of paper, but the binding is still of war-time quality.

E. R. CROWDER.

[1] DIAGNOSIS AND TREATMENT OF MENSTRUAL DISORDERS AND STERILITY. By Charles Mazer, M.D., and S. Leon Israel, M.D. 2d ed. rev. New York, London: Paul B. Hoeber, Inc., 1946.

[2] ADOLESCENT STERILITY. By M. F. Ashley Montagu. Springfield, Illinois: Charles C. Thomas Publishers. 1946.

[3] A MANUAL OF TOMOGRAPHY. By M. Weinbren, B. Sc. (S.A.), M.R.C.S. (Eng.), L.R.C.P. (Lond.), F.F.R. (Lond.), D.M.R.E. (Camb.). London: H. K. Lewis & Co., Ltd., 1946.

THE seventh volume[1] of the *Encyclopedia of Endocrinology* by Hans Selye is a monumental documentation of most of the world's literature on the subject of ovarian tumors presented in outline looseleaf notebook fashion. An additional 427 page volume of bibliography accompanies the text. Many thousands of references have been collected, classified, and reviewed. This volume is part of an encyclopedia of endocrinology which, according to the author, is a "first tentative effort to make the entire endocrine literature easily accessible to research workers and clinicians." All bibliographical information has been carefully checked for correctness and the investigator seeking a basic bibliography on any phase of ovarian neoplasms will find it of inestimable help. The magnitude of the task has made it obviously impossible for the author to evaluate critically all of the assembled data: as a result the reader will at times be somewhat confused by the mass of uncorrelated facts.

This text should unquestionably be available for reference purposes in the library of every teaching institution. It is doubtful if students or clinicians will find it a satisfactory substitute for more orthodox textbooks of gynecological pathology.

JOHN W. HUFFMAN.

[1] ENCYCLOPEDIA OF ENDOCRINOLOGY. By Hans Selye, M.D., Ph.D., D. Sc., F.R.S. (Canada). Sect. IV, Vol. 7, Ovarian Tumors. Montreal: Richardson, Bond and Wright. 1946.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

UTERINE CONTRACTILITY IN PREGNANCY. By Douglas P. Murphy, M.D., F.A.C.S. Philadelphia, London, Montreal: J. B. Lippincott Co., 1947.

DIAGNOSTIC HORMONAL ET TRAITEMENTS HORMONAUX EN GYNECOLOGIE. By Claude Beclere. Paris: Masson & Cie., Editeurs, 1946.

D'HYPERFOLLICULINIE ÉTUDE CLINIQUE, ANATOMO-PATHOLOGIQUE ET THÉRAPEUTIQUE. By Max Wallet. Paris: Masson et Cie, Editeurs, 1946.

THE 1946 YEAR BOOK OF GENERAL SURGERY. Edited by Evarts A. Graham, A.B., M.D. Chicago: The Year Book Publishers, Inc., 1947.

MEDICINE IN THE CHANGING ORDER. REPORT OF THE NEW YORK ACADEMY OF MEDICINE COMMITTEE ON MEDICINE AND THE CHANGING ORDER. New York: The Commonwealth Fund, 1947.

PHYSICAL MEDICINE IN GENERAL PRACTICE. THE AMERICAN PRACTITIONER SERIES. Edited by Arthur L. Watkins, M.D. Philadelphia, London, Montreal: J. G. Lippincott Co., 1946.

DIE HORMONVERSORGUNG DES FOETUS. By Dr. Jules Samuels. Leiden, Netherlands: E. J. Brill, 1947.

ESSENTIALS OF ENDOCRINOLOGY. By Arthur Grollman, Ph.D., M.D., F.A.C.P. Philadelphia: J. B. Lippincott Co., 1947.

A HANDBOOK OF COMMONLY USED DRUGS. By Michel Pijoan and Clark H. Yaeger. Springfield, Ill.: Charles C Thomas, 1947.

TECHNIQUES AND PROCEDURES IN ANESTHESIA. By John Adriani, M.D. Springfield, Ill.: Charles C Thomas, 1947.

PRINCIPLES AND PRACTICE OF OBSTETRICS. By Joseph B. De Lee, M.D., and J. P. Greenhill, M.D. 9th ed. Philadelphia and London: W. B. Saunders Co., 1947.

FUNDAMENTALS OF CLINICAL NEUROLOGY. By H. Houston Merritt, M.D., Fred A. Mettler, M.D., Ph.D., and Tracy Jackson Putnam, M.D. Philadelphia, Toronto: The Blakiston Co., 1947.

UTEROTUBAL INSUFFLATION. A CLINICAL DIAGNOSTIC METHOD OF DETERMINING THE TUBAL FACTOR IN STERILITY INCLUDING THERAPEUTIC ASPECTS AND COMPARATIVE NOTES ON HYSTEROSALPINOGRAPHY. By I. C. Rubin, M.D., F.A.C.S. St. Louis: C. V. Mosby Co., 1947.

DISEASES OF THE NOSE AND THROAT. 3rd ed. By Charles J. Imperatori, M.D., F.A.C.S., and Herman J. Burman, M.D., F.A.C.S. Philadelphia, London, Montreal: J. B. Lippincott Co., 1947.

DIE HORMONALEN ASPEKTE DES FORTPFLANZUNGS-PROZESSES. By Dr. Jules Samuels. Amsterdam, Holland: Holdert & Co., N.V., 1946.

SYNOPSIS OF OPERATIVE SURGERY. By H. E. Mobley, M.D., F.A.C.S. 2nd ed. St. Louis: The C. V. Mosby Co., 1947.

EXPERIENCES WITH FOLIC ACID. Tom D. Spies, M.D. Chicago: The Year Book Publishers, Inc., 1947.

DIAGNOSTIC NEURO-CHIRURGICAL. By Jean Guillaume and Jean Sigwald. Paris: Presses Universitaires de France, 1947.

THE PHARMACOPOEIA OF THE UNITED STATES OF AMERICA. 13th ed. Prepared by the Committee of Revision and published by the Board of Trustees of the United States Pharmacopoeial Convention. Easton, Pa.: Mack Publishing Company, April 1, 1947.

PENICILLIN THERAPY; INCLUDING STREPTOMYCIN, TYROTHRICIN AND OTHER ANTIBIOTIC THERAPY. By John A. Kolmer, M.S., M.D., Dr. P. H., Sc.D., LL.D., L.H.D., F.A.C.P. 2nd ed. New York, London: D. Appleton-Century Company, 1942.

IF YOU NEED AN OPERATION. By Richard A. Leonardo, M.D., Ch.M., F.I.C.S. New York: Froben Press, 1947.

EYE SURGERY. By H. B. Stallard, M.B.E., M.D. (Cantab.), F.R.C.S. (Eng.). Baltimore: The William & Wilkins Co., 1946.

CLEFT PALATE AND SPEECH. By Muriel E. Morley, B.Sc., F.C.S.T. Edinburgh: E. & S. Livingstone Ltd., 1945.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch. (Edin.), F.R.C.S. (Eng.). Baltimore: The Williams & Wilkins Co., 1946.

THE DEVELOPMENT OF INHALATION ANAESTHESIA; WITH SPECIAL REFERENCE TO THE YEARS 1846–1900. By Barbara M. Duncum. London, New York, Toronto: Oxford University Press, 1947.

DR. SAMUEL GUTHRIE DISCOVERER OF CHLOROFORM. By Jesse Randolph Pawling. Watertown, N.Y.: Brewster Press, 1947.

BIBLIOTECA DE LA ENFERMERA DE CIRUGIA; ASISTENCIA DE LOS ENFERMOS TORACOPULMONARES. By Hernan D. Aguilar. Buenos Aires: Libreria "El Ateneo," 1946.

THE 1946 YEAR BOOK OF OBSTETRICS AND GYNECOLOGY. Edited by J. P. Greenhill, B.S., M.D., F.A.C.S. Chicago: The Year Book Publishers, Inc., 1947.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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PRELIMINARY PROGRAM FOR 1947 CLINICAL CONGRESS, THE WALDORF-ASTORIA, NEW YORK, SEPTEMBER 8 TO 12, 1947

THE American College of Surgeons will hold its thirty-third annual Clinical Congress in New York from September 8 to 12, with headquarters at The Waldorf-Astoria. The five-day program includes operative and nonoperative clinics, scientific sessions in surgery and the surgical specialties, hospital conferences, showings of medical motion pictures, official meetings, and educational and technical exhibits. As one of the leading medical events of the year, the Clinical Congress provides excellent opportunities for presentation of the latest developments in surgery and related fields, and its educational value for the individual surgeon and the entire profession is well recognized.

All types of instructional methods are employed: first hand observation in the operative clinics; visual demonstration in nonoperative clinics and in surgical films; lecture type presentations in symposia; formal addresses, such as the Presidential Address and the Martin Memorial Lecture; forums in which a great many speakers can participate; informal panel discussions in which descriptions of new ideas and techniques may be described and commented upon; scientific exhibits in which developments in surgery and activities related thereto are portrayed in chart and graph form; and displays of new equipment and other products in which technical developments which increase the efficiency of the surgeon may be studied.

CLINICS

The New York Committee on Arrangements has appointed a clinic committee composed of representatives of the New York hospitals which will participate in the clinical program. Every effort is being made by both of these committees to insure a clinic program that will give the visiting surgeons a comprehensive idea of the surgical resources of the New York metropolitan area, with the program of the general hospitals arranged to cover clinics in general surgery, obstetrics and gynecology, fractures, orthopedic surgery, thoracic surgery, neurosurgery, genitourinary surgery, and ophthalmology and otolaryngology. Special hospitals will also arrange clinics in their fields. General and special demonstrations will be held on subjects such as fractures, cancer, maternal morbidity, and end-result studies; newer diagnostic and therapeutic procedures; preoperative and postoperative supportive treatment; anesthesia; and reconditioning.

PRESIDENTIAL MEETING

The Presidential Meeting will be held on Monday evening, September 8, in the Grand Ballroom. The program will include the inaugural ceremony for the incoming officers. Dr. Irvin Abell will give the Presidential Address. Dr. Allen O. Whipple of New York, Clinical Director of Memorial Hospital for the Treatment of Cancer and Allied Diseases, will present the second Martin Memorial

Lecture. He has selected as his subject, "The Qualifications of the Surgeon and the Cancer Problem."

CONVOCATION

The Convocation will be held on Friday evening in the Grand Ballroom. It will open with a processional of officers, regents, governors, and initiates. The new President, Dr. Arthur W. Allen, will preside and will confer the fellowships and the honorary fellowships. Dr. Irvin Abell, Past President and Chairman of the Board of Regents, will present the candidates for fellowship.

GENERAL SURGERY

In general surgery, the program at the headquarters hotel will embrace three evening symposia and seven afternoon panel discussions, all on very timely themes.

The Tuesday evening symposium will be on "The Proper Use of Blood and Blood Plasma" with the following subjects and speakers: "A Permanent Red Cross Transfusion Service," G. Foard McGinnes, Washington, D. C.; "Blood Bank Organization," Paul I. Hoxworth, Cincinnati; "Reactions to Blood Transfusion and the Rh Factor," Louis K. Diamond, Boston; "The Use of Blood and Plasma in Surgery," Dallas B. Phemister, Chicago.

The Wednesday evening symposium will be on "Nutritional Requirements in Surgery" with the following subjects and speakers: "Proper Employment of Oral Feeding," (speaker to be announced); "Parenteral Feeding (including use of amino acids and glucose)," Robert Elman, St. Louis; "The Importance of Adequate Supply of Blood and Nourishment for Wound Healing," Champ Lyons, New Orleans.

The Thursday evening symposium will be on "Hypertension" with the following subjects and speakers: "Fundamental Physiological Considerations," Peter Heinbecker, St. Louis; "Indications for Surgery in the Treatment of Hypertension," Thomas P. Findley, New Orleans; "Surgical Procedures in the Treatment of Hypertension," Reginald H. Smithwick, Boston; "End Results in the Treatment of Hypertension," (speaker to be announced).

The following subjects have been chosen for the afternoon panel discussions in general surgery. Participants are shown in so far as acceptances had been received at the time copy for this issue was prepared:

Pulmonary Suppuration—Monday, 1:30 to 3:00 p.m. Leader: Evarts A. Graham, St. Louis; Collaborator: Brian Blades, Washington, D.C.

Pancreatitis—Monday, 3:30 to 5:00 p.m. Leader: Mims Gage, New Orleans; Collaborators: John M. Waugh, Rochester, Minnesota; Horace J. McCorkle, San Francisco

Surgery of the Hand—Tuesday, 1:30 to 3:00 p.m. Leader: Henry C. Marble, Boston; Collaborators: Harvey S. Allen, Chicago, L. H. McKim, Montreal, and J. Harold Couch, Toronto

Jaundice—Tuesday, 3:30 to 5:00 p.m. Leader: Charles B. Puestow, Chicago; Collaborators: I. S. Ravdin, Philadelphia, James T. Priestley, Rochester, Minnesota

Gastric Surgery—Wednesday, 1:30 to 3:00 p.m. Leader: Howard K. Gray, Rochester

Use of Antibiotic Agents and Chemotherapy in Surgery—Wednesday, 3:30 to 5:00 p.m. Leader: John S. Lockwood, New York; Collaborators: C. Phillip Miller, Chicago, Frank L. Meleney, New York, Harold A. Zintel, Philadelphia, Edwin J. Pulaski, Fort Sam Houston, Texas

Late Results of Compound Craniocerebral Injuries—Thursday, September 11, 3:30 to 5:00 p.m. Leader: A. Earl Walker, Chicago; Collaborators: James C. White, Boston, and Cobb Pilcher, Nashville

OPHTHALMOLOGY

An exceptionally interesting program is being planned for ophthalmologists, consisting of two evening symposia, three morning panel discussions from 9:00 to 10:30, and an evening session on Wednesday in which a combined program with the otorhinolaryngologists will be held.

Subjects for the Tuesday evening symposium will be: "Epithelial Downgrowth Following Cataract Operation," "Local Anesthesia in Ophthalmology," "Operative Treatment of Vertical Tropias," "Antibiotics—Prevention and Treatment of Postoperative Complication of Cataract Extraction."

Subjects for the Thursday evening symposium will be: "Surgical Physiology of the Eye Muscles—with Special Reference to Squint," "Glaucoma following Cataract Extraction," "Retinal Detachment," "The Difficult Cataract Extraction."

Subjects for the morning panel discussions will be: Tuesday—"Surgery of Extraoscular Muscles"; Wednesday—"Surgery of Glaucoma"; Thursday—"Angiospastic Ocular Lesions."

Subjects for the Wednesday evening combined session on ophthalmology—otorhinolaryngology will be: "Blood Supply of Eye and Sinuses," "Dacryocystorhinostomy," "Sinus Surgery in Eye Diseases," "Ophthalmoneurological Symptoms in Nasopharyngeal Tumors."

OTORHINOLARYNGOLOGY

The program in otorhinolaryngology will consist of two evening symposia, three morning panel discussions from 10:45 to 12:15, and an evening session on Wednesday in which a combined program with the ophthalmologists will be held. The fact that the morning panel discussions are planned this year to follow those on ophthalmology instead of being held simultaneously, will enable surgeons who combine these specialties in their practice to attend both sessions.

The subjects for the evening symposia will be: Tuesday—"Bronchiectasis"; Thursday—"Surgical Management of Carcinoma of the Larynx."

The subjects for the Wednesday evening combined session are listed in the preceding section on ophthalmology.

Tentative subjects for the panel discussions are as follows: "Repair of Bilateral Adductor Paralysis of the Vocal Cords," "Anesthesia for Ear, Nose and Throat Surgery," and "Rhinoplasty."

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems will be conducted on Tuesday, Wednesday, Thursday, and Friday mornings. The Forum affords a large surgical audience the opportunity to become acquainted with the work of many productive clinical and experimental investigators through the medium of the concise presentation; at the same time, it gives a number of young, well trained surgeons their first opportunity of a hearing before a national surgical organization. It is the professed purpose of the Surgical Forum, as expressed by Dr. Owen H. Wangensteen, Chairman of the Forum Committee, to "attempt to bring before its assembly each year the best that is new in surgery; announcement of new found knowledge of special interest to surgeons and wider dissemination of new, significant information in the interphases between surgery and allied medical specialties suggests the objectives which the sponsors have in mind in the formulation of programs for presentation."

Selection of papers for the New York Clinical Congress is now being made by the committee, which is guided by originality of thought and interest suggested in the abstract submitted by the author. Each speaker is allowed 10 minutes for his presentation.

A total of 93 talks were given at the Surgical Forums in Cleveland.

SPECIAL SYMPOSIA

A symposium on fractures and other traumas will be held on Tuesday afternoon, a symposium on cancer on Wednesday afternoon, and a symposium on graduate training in surgery on Thursday afternoon.

SPECIALTY PANEL DISCUSSIONS

Panel discussions on the surgical specialties will be held on Friday afternoon, hours and programs to be announced later. The panels will be held concurrently in the following fields: orthopedic surgery, neurosurgery, plastic surgery, obstetrics and gynecology, urology and thoracic surgery.

HOSPITAL STANDARDIZATION CONFERENCE

The first formal session of the Clinical Congress will be the opening meeting of the twenty-sixth Hospital Standardization Conference. Dr. Irvin Abell of Louisville, President of the College, will preside. The hospital conferences will continue on Monday afternoon, with sessions following on Tuesday, Wednesday, and Thursday mornings, afternoons, and evenings.

Hospital administrators, members of governing boards, heads of the various hospital departments and their personnel, nursing groups, and many other persons directly or indirectly concerned about hospital progress will be interested in the discussion of current hospital problems. National organizations representing various groups of hospital personnel will co-operate and participate in the meetings, which will include formal sessions, panel discussions, round table conferences, and open forums.

MEDICAL MOTION PICTURES

The latest available films showing surgical procedures and related subjects will be shown in the medical motion picture exhibits which will be held daily. These are a much appreciated feature of the Clinical Congress.

Both sound and silent, standard and color films will be shown, all of which have been approved by the Committee on Medical Motion Pictures.

TECHNICAL AND SCIENTIFIC EXHIBITION

The technical exhibit, together with the registration and clinic ticket bureaus, will be located in the Basildon Room, Jade Room, and Astor Gallery, all on the third floor of the hotel. Leading manufacturers of surgical instruments, x-ray apparatus, sterilizers, operating room lights, ligatures, dressings, hospital apparatus and supplies of all kinds, and pharmaceuticals, and publishers of medical books will be represented in the exhibition. The technical exhibits will demonstrate many of the new features learned from our experience in the war.

ADVANCE REGISTRATION

The hospitals and medical schools of New York afford accommodations for a large number of visiting surgeons. However, in order to insure against overcrowding, attendance at the Congress will be limited to the number that can be accommodated at the clinics and meetings. It is therefore expected that surgeons who wish to attend the Congress will register in advance.

Because of greatly increased costs and expenses to which the College will be subjected this year in connection with its New York Clinical Congress, the Board of Regents has found it necessary to require a registration fee of $5.00 for Fellows and for endorsed Junior Candidates. Non-Fellows attending as invited guests of the College will pay a fee of $10.00. No fee will be required of initiates of the class of 1947.

To each surgeon who registers in advance a formal receipt will be issued. This is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card is not transferable and must be presented in order to obtain clinic tickets and admission to scientific sessions.

The registration desk will be open from 4:00 to 9:00 p.m. on Sunday, September 7, in order to permit surgeons to obtain tickets for the Monday clinics. A new plan is to be adopted in New York of distributing clinic tickets on the day prior to the clinics, from 9:00 a.m. to 5 p.m. Any remaining tickets will be available at 7:00 a.m. the same day on which the clinics are held.

HOTEL RESERVATIONS

Although the prospect is that the hotel situation in New York will be more favorable than it would have been last year, nevertheless there is still a critical shortage of hotel rooms and early reservations are most desirable. In making these, communications should be addressed to the New York Convention Bureau, through which all reservations for the Clinical Congress are to clear. No correspondence should be sent directly to the hotels. A letter has been sent to Fellows in which the procedure is outlined. With this letter was enclosed a form to be used in making reservations. Choices of hotels may be designated. The following hotels are recommended by the Committee:

	Minimum Rates with Bath	
	Single	Double
Allerton House, 143 East 39th Street	$2.75	$
Allerton House for Women, 130 East 57th Street	3.00	
Ambassador, Park Avenue and 51st Street	$6.00	
Astor, Broadway and 44th Street	3.50	$4.00
Barbizon (Women), Lexington Avenue and 63rd Street	3.50	
Barclay, 111 East 48th Street	6.00	8.00
Belmont Plaza, Lexington Avenue and 49th Street	4.00	6.00
Beverly, Lexington Avenue and 50th Street	5.00	
Biltmore, Madison Avenue and 43rd Street	5.50	7.50
Bristol, 129 West 48th Street	2.50	3.50
Capitol, 51st Street and 8th Avenue	3.00	4.50
Carlyle, Madison Avenue at 76th Street	6.00	
Chesterfield, 130 West 49th Street	2.50	4.00
Commodore, Lexington Avenue and 42nd Street	3.50	5.50
Concourse Plaza, Grand Concourse and 161st Street	3.50	5.50
Cornish Arms, 311 West 23rd Street	2.25	4.00
Delmonico, 502 Park Avenue	6.00	8.00
Essex House, 160 Central Park South	6.00	8.00
Fifth Avenue Hotel, 24 Fifth Avenue (9th Street)	4.00	6.00
Governor Clinton, 31st Street and 7th Avenue	3.30	4.40
Henry Hudson, 353 West 57th Street	2.50	3.50
Kenmore Hall, 145 East 23rd Street	2.00	3.50
Lexington, 48th Street and Lexington Avenue	4.00	6.00
Luxor Baths Hotel, 121 West 46th Street	2.25	
McAlpin, Broadway and 34th Street	3.30	4.95
Martinique, Broadway at 32nd Street	2.75	3.85
Midston House, 22 East 38th Street	3.50	4.00
New Weston, Madison Avenue and 50th Street	4.00	7.00
New Yorker, 34th Street and 8th Avenue	3.85	5.50
Paramount, 46th Street, West of Broadway	3.00	5.00
Park Central, 7th Avenue and 55th Street	4.00	6.00
Parkside, 18 Gramercy Park South	2.75	
Pennsylvania, 7th Avenue and 33rd Street	3.85	5.50
Piccadilly, 227 West 45th Street	3.00	5.00
Plymouth, 143 West 40th Street	2.50	3.50
President, 234 West 48th Street	2.50	4.00
Prince George, 14 East 28th Street	2.50	4.00
Roosevelt, Madison Avenue and 45th Street	4.50	6.50
Shelton, 49th Street and Lexington Avenue	3.50	5.00
Taft, 7th Avenue and 50th Street	3.00	5.00
Times Square, 43rd Street and 8th Avenue	2.25	4.00
Tudor, 304 East 42nd Street	2.50	
Victoria, 7th Avenue and 51st Street	3.00	4.50
Waldorf-Astoria, 50th Street and Park Avenue	7.00	
Warwick, 54th Street at Sixth Avenue	5.00	
Wellington, 7th Avenue and 55th Street	3.00	4.50
Woodstock, 127 West 43rd Street	3.00	5.00